DEFENSE INFORMATION SYSTEMS AGENCY
P. O. BOX 549
FORT MEADE, MARYLAND 20755-0549

IN REPLY REFER TO: Joint Interoperability Test Command (JTE) **31 May 12**

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Special Interoperability Test Certification of the Fujitsu FLASHWAVE 9500, Fixed Network Element (F-NE), with Software Release Version 4.1.4

References: (a) Department of Defense Directive 4630.05, "Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," 5 May 2004
(b) Department of Defense Instruction 8100.04, "DoD Unified Capabilities (UC)," 9 December 2010
(c) through (e), see Enclosure 1

1. References (a) and (b) establish the Joint Interoperability Test Command (JITC), as the responsible organization for interoperability test certification.

2. The Fujitsu FLASHWAVE 9500, with Software Release 4.1.4, is hereinafter referred to as the System Under Test (SUT). The SUT meets all its critical interoperability requirements and JITC certifies the SUT for joint use in the Defense Information Systems Network (DISN) as a F-NE. The SUT provides additional optical transport interfaces and functional capabilities. JITC evaluated and certifies the SUT for optical transport for the Optical Carrier interfaces detailed in Table 1. Additional sponsor functional capabilities are addressed in Table 2. The operational status of the SUT will be verified during deployment. Any new discrepancies that are discovered in the operational environment will be evaluated for impact and adjudicated to the satisfaction of the Defense Information Systems Agency (DISA) via a vendor Plan of Action and Milestones to address the concern(s) within 120 days of identification. JITC conducted testing using F-NE requirements within the Unified Capabilities Requirements (UCR) 2008, Change 1, Reference (c), and other sponsor requested requirements. The JITC tested the SUT using F-NE test procedures, Reference (d) and test procedures developed to address the sponsor unique requirements. JITC does not certify any other configurations, features, or functions, except those cited within this memorandum. This certification expires upon changes that affect interoperability, but no later than three years from the date of this memorandum.

3. This finding is based on interoperability testing conducted by JITC, review of the Vendor's Letter of Compliance and Information Assurance (IA) Certification Authority (CA) approval of the IA configuration. JITC conducted Interoperability testing at the Indian Head, Maryland, Test Facility from 6 July through 27 August 2010. The DISA IA CA has reviewed the JITC published IA Assessment Report for the SUT, Reference (e), and provided a positive recommendation of the IA configuration on 19 January 2011. The acquiring agency or site will be responsible for the DoD Information Assurance Certification and Accreditation Process

(DIACAP) accreditation. The Army originally submitted the SUT as a DISN Optical Transport System under UCR 2008 Section 5.5. Based on DISA guidance received 18 January 2012, this product was re-evaluated as a F-NE. Enclosure 2 documents the test results and describes the tested network and system configurations. Enclosure 3, System Functional and Capability Requirements, lists the F-NE Capability Requirements (CR) and Functional Requirements (FR).

4. Section 5.9 of the UCR establishes the interfaces and threshold CRs/FRs used to evaluate the interoperability of the SUT as an F-NE. Tables 1 and 2 list the F-NE, sponsor requested interfaces, CRs, FRs, and the component status of the SUT.

Table 1. SUT Interface Interoperability Status

Interface		Critical (See note)	UCR Ref (UCR 2008, Change 1)	Threshold CR/FR	Status	Remarks
NE	Analog	No	5.9.2.3.1	1,2,4	NA	Not supported by the SUT.
	Serial	No	5.9.2.3.2	1,2,4	NA	Not supported by the SUT.
	BRI ISDN	No	5.9.2.3.3	1,2,4	NA	Not supported by the SUT.
	DS1	No	5.9.2.3.4	1,2,3,4	NA	Not supported by the SUT.
	E1	No	5.9.2.3.5	1,2,3,4	NA	Not supported by the SUT.
	DS3	No	5.9.2.3.6	1,2,3,4	NA	Not supported by the SUT.
	OC-X	No	5.9.2.3.8	1,2,3,4	Certified	SUT met requirements for the following interfaces: OC-48/STM-16; OC-192/STM-64; and, OC-768/STM-256.
	IP (Ethernet) 10/100/1000 and 10GbE	No	5.9.2.3.9	1,2,4,7	Certified	SUT met requirements for specified interfaces.
NM	10Base-X	Yes	5.3.2.4.4	8	Certified	SUT met NM requirements for specified interfaces.
	100Base-X	Yes	5.3.2.4.4	8	Certified	
OTHER	10 GbE-LAN	No	5.9.2.3.9	1,2,4,7	Certified	SUT met requirements for specified interfaces.
	10 GbE-WAN	No	5.9.2.3.9	1,2,4,7	Certified	SUT met requirements for specified interfaces.
	OSC	No	5.9.2.3.9	1,2,3,4,5	Certified	SUT met requirements for specified interfaces.

NOTE: UCR does not specify any minimum interfaces. The SUT must minimally provide one of the listed ingress and egress interfaces specified.

LEGEND:

100Base-X	100 Mbps Ethernet generic designation	LAN	Local Area Network
10Base-X	10 Mbps Ethernet generic designation	Mbps	Megabits per second
BRI	Basic Rate Interface	NA	Not Applicable
CR	Capability Requirement	NE	Network Element
DS1	Digital Signal Level 1 (1.544 Mbps)	NM	Network Management
DS3	Digital Signal Level 3 (44.736 Mbps)	OC-X	Optical Carrier - X (OC-3, OC-12, etc.,)
DWDM	Dense Wavelength Division Multiplexing	OSC	Optical Supervisory Channel
E1	European Interface Standard (2.048 Mbps)	OTS	Optical Transport System
F-NE	Fixed Network Element	SONET	Synchronous Optical Network
FR	Functional Requirement	STM	Synchronous Transport Module
GbE	Gigabit Ethernet	SUT	System Under Test
IP	Internet Protocol	UCR	Unified Capabilities Requirements
ISDN	Integrated Services Digital Network	WAN	Wide Area Network

Table 2. SUT CRs and FRs Status

CR/FR ID	Capability/Function	Applicability (See note 1)	UCR Ref (UCR 2008, Change 1)	Status	Remarks
F- NE CR/FR					
1	**General NE Requirements**				
	General Requirements	Required	5.9.2.1	Met	
	Alarms	Required	5.9.2.1.1	Met	
	Congestion Control & Latency	Required	5.9.2.1.2	Met	
2	**Compression**				
	G.726	Conditional	5.9.2.2	NA	Not supported by the SUT.
	G.728	Conditional	5.9.2.2	NA	Not supported by the SUT.
	G.729	Conditional	5.9.2.2	NA	Not supported by the SUT.
3	**Interface Requirements**				
	Timing	Required	5.9.2.3.7	Met	
4	**Device Management**				
	Management Options	Required	5.9.2.4.1	Met	
	Fault Management	Conditional	5.9.2.4.2	Met	
	Loop-Back Capability	Conditional	5.9.2.4.3	Met	
	Operational Configuration Restoral	Required	5.9.2.4.4	Met	
5	**DLoS**				
	DLoS Transport	Conditional	5.9.2.4.5	NA	Not supported by the SUT.
6	**IPv6 Requirements**				
	Product Requirements	Required	5.3.5.4	Met	SUT is a Layer-2 device and transports IPv4 and IPv6 traffic transparently.
7	**NM Requirements**				
	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Met	
	General Management Requirements	Required	5.3.2.17.2	Met	
Other Tested Requirements					
8	**Requirements Applicable to all OTS Elements**				
	Overall Requirements	Conditional	5.5.3.2.2.1	Partially Met	Certified based on sponsor requirements. See Note 2.
	Performance Requirements	Conditional	5.5.3.2.2.2	Met	
	Reliability and Quality Assurance	Conditional	5.5.3.2.2.2.1	Partially Met	Certified based on sponsor requirements. See Note 3.
	Common Physical Design Requirements	Conditional	5.5.3.2.2.3	Met	
	Protection and Restoration	Conditional	5.5.3.2.2.4	Met	
	Optical Amplifier Requirements				
	OLA Physical Design Requirements	Conditional	5.5.3.2.3.1	Not Met	See Note 4.
	Muxponder Requirements				
	Muxponder	Conditional	5.5.3.2.4	Partially Met	Certified based on sponsor requirements. See Note 5.
	Transponder Requirements				
	Transponder	Conditional	5.5.3.2.5	Partially Met	Certified based on sponsor requirements. See Note 6.
	Interface Requirements	Conditional	5.5.3.2.5.1	Partially Met	Certified based on sponsor requirements. See Note 7.
	ROADM Requirements				
	ROADM Requirements	Conditional	5.5.3.2.6	Partially Met	Certified based on sponsor requirements. See Note 8.
	ROADM Specific Physical Design Requirements	Conditional	5.5.3.2.6.1	Met	

Table 2. SUT CRs and FRs Status (continued)

	Requirements Common to Transponder and ROADM				
	Framed Formats	Conditional	5.5.3.2.7.1	Partially Met	Certified based on sponsor requirements. See Note 9.
	Unframed Formats	Conditional	5.5.3.2.7.2	Partially Met	Certified based on sponsor requirements. See Note 10.
	Optical Supervisory Channel Requirements				
	Optical Supervisory Channel	Conditional	5.5.3.2.8	Partially Met	Certified based on sponsor requirements. See Note 11.
	OTS Standard Compliance	Conditional	5.5.3.2.9	Partially Met	Certified based on sponsor requirements. See Note 12.
9	**TSF Requirements**				
	TSF SONET/SDH	Required	5.5.3.3.2	Partially Met	Certified based on sponsor requirements. See Note 13.
	TSF Ethernet	Required	5.5.3.3.3	Partially Met	Certified based on sponsor requirements. See Note 14.
	TSF Framing Requirements	Required	5.5.3.3.4	Met	
	TSF Switch Fabric	Required	5.5.3.3.5	Partially Met	Certified based on sponsor requirements. See Note 15.
	TSF Performance	Required	5.5.3.3.6	Met	
	General Link Protection	Required	5.5.3.3.7	Partially Met	Certified based on sponsor requirements. See Note 16.
	Linear Protection	Required	5.5.3.3.8	Partially Met	Certified based on sponsor requirements. See Note 17.
	Ring Protection	Required	5.5.3.3.19	Partially Met	Certified based on sponsor requirements. See Note 18.
	Fault management	Required	5.5.3.3.10	Met	
	Performance Management	Required	5.5.3.3.11	Partially Met	Certified based on sponsor requirements. See Note 19.
	EMS	Required	5.5.3.3.12	Partially Met	Certified based on sponsor requirements. See Note 20.
	Physical Design	Required	5.5.3.3.13	Met	
	Standards Compliance	Required	5.5.3.3.14	Partially Met	Certified based on sponsor requirements. See Note 21.

Table 2. SUT CRs and FRs Status (continued)

NOTES:

1. Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.
2. SUT does not support 100G interface, 100G transponder, pre-dispersion compensation, and multiple DWDM span reach requirements. SUT supports 450km over SMF, 930km over NZDSF for 40G, 135km length and 35dB spans loss.
3. SUT does not support software upgradeability in a modular fashion as required by the UCR. The OTS' requirement for a minimum of eight user-defined remote control points for external functions but SUT supports only four user-defined remote control points.
4. SUT does not support Raman Amplifiers and internal Optical Spectrum Analyzer. SUT supports 135km / 35dB spans loss and pre-dispersion compensation.
5. SUT does not support a Four-to-one Muxponder.
6. SUT does not support 100G transponder. SUT supports SR, IR-1, R2, LR-1, LR-2 for OC-48, OC-192 interfaces. SUT also supports 1200km over SMF, 930km over NZDSF for 10G, 450km over SMF, and 930km over NZDSF for 40G.
7. SUT supports OTU-2 and OTU-3 at the client and network sides except for 40G interface, which supports OTU-3 at the network side.
8. SUT does not supports the direction-less wavelength routing, colorless wavelength routing, cascading of eight or more ROADMs, configuration for it to pass-through all wavelengths those are not explicitly dropped or added. SUT also does not support dynamic wavelength selection without pre-cabling, adding or dropping all wavelengths from each of eight line-side fiber connections to tributary side optics, wavelength hair-pinning capability, wavelength regeneration including wavelength conversion using back-to-back transponders or through-transponders via hair-pinning, and optical multicasting capability.
9. SUT supports OTU-2 and OTU-3 at the client and network sides except for 40G interface, which supports OTU-3 at the network side.
10. SUT supports mixed framed and unframed wavelength services via ALIEN wavelength .
11. SUT GNE will not communicate with other Nodes in the absence of an OSC. SUT supports 135km length and 35dB spans loss for OSC.
12. SUT supports OTU-2 and OTU-3 at the client and network sides except for 40G interface, which supports OTU-3 at the network side.
13. SUT does not support selection of SONET or SDH per card or port level. However, SONET or SDH is set at the system level meaning either SUT is set for entirely SDH or set for entirely SONET. SUT also does not support 40G switching as SONET or SDH in TSF mode. However, SUT does support 40G interface as SONET and SDH in OTS mode, SR, LR-1, LR-2, LR-3, and IR-1, IR-2, IR-3 for OC-48 and OC-192 interfaces, and VSR for STM-256 all application codes supported for various values of n and x.
14. SUT does not support LCAS in SDH mode.

Table 2. SUT CRs and FRs Status (continued)

NOTES (continued):
15. SUT supports VCAT and VC-4 granularity.
16. 1:N and 4-Fibers BLSR are not supported by the SUT.
17. 1:1 is not supported by the SUT.
18. 4-Fibers BLSR is not supported by the SUT.
19. The SUT does not track PM data with 5-m intervals and also does not track frame errors, P-Bit Parity Errors, C-Bit Parity Errors, FEBE, layer-1 statistics, layer-2 errors, and all QoS parameters defined for the RPR. However, the SUT supports Block Error PMs for SDH but only Bit-error PMs for SONET, and all PMs are collected in 15-m intervals.
20. SUT does not support RPR and does not track PM data with 5- m intervals. SUT also does not track frame errors, P-Bit Parity Errors, C-Bit Parity Errors, and FEBE.
21. SUT does not support RPR.

LEGEND:

ANSI	American National Standards Institute	NA	Not Applicable
ADPCM	Adaptive Differential Pulse Code Modulation	NE	Network Element
BLSR	Bidirectional Line Switched Ring	NM	Network Management
CR	Capabilities Requirement	NMS	Network Management System
CS-ACELP	Conjugate Structure Algebraic Code-Excited Linear Prediction	NZDSF	Non-Zero Dispersion Shifted Fiber
		OC	Optical Carrier
dB	Decibel	OLA	Optical Line Amplifier
DLoS	Direct Line of Sight	OSC	Optical Supervisory Channel
DWDM	Dense Wavelength Division Multiplexing	OTN	Optical Transport Network
EMS	Element Management System	OTS	Optical Transport System
F-NE	Fixed-Network Element	OTU	Optical Transport Unit
FEBE	Front End/Back End	PM	Power Management
FR	Functional Requirement	QoS	Quality of Service
G	Gigabit	RPR	Resilient Packet Rings
G.726	ITU-T speech codec for ADPCM (32 Kbps)	ROADM	Reconfigurable Optical Add-Drop Multiplexor
G.728	ITU-T speech codec for LD-CELP (16 Kbps)	SDH	Synchronous Digital Hierarchy
G.729	ITU-T speech codec for CS-ACELP (8 Kbps)	SMF	System Management Facility
GNE	Gateway Network Element	SONET	Synchronous Optical Transport Network
ID	Identification	SR	Short Reach
IP	Internet Protocol	STM	Synchronous Transport Module
IPv4	Internet Protocol version 4	SUT	System Under Test
IPv6	Internet Protocol version 6	T1.105-2001	SONET – Basic Description including Multiplex Structure, Rates, and Formats, May 2001.
IR	Intermediate Reach		
ITU-T	International Telecommunication Union - Telecommunication	TDM	Time Division Multiplexing
		TSF	Transport Switch Function
Kbps	Kilobits per second	UCR	Unified Capabilities Requirements
km	kilometer	VC	Virtual Circuit
LCAS	Link Capacity Adjustment Scheme	VCAT	Virtual Concatenation
LD-CELP	Low Delay-Code Excited Linear Prediction	VSR	Very Short Reach
LR	Long Reach	VVoIP	Voice and Video over Internet Protocol
m	minute		

5. In accordance with the Program Manager's request, JITC did not develop a detailed test report. JITC distributes interoperability information via the JITC Electronic Report Distribution system, which uses Non-secure Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System Tracking Program, which .mil/.gov users can access on the NIPRNet at https://stp.fhu.disa.mil. Test reports, lessons learned, and related testing documents and references are on the JITC Joint Interoperability Tool at http://jitc.fhu.disa.mil (NIPRNet). Information related to Defense Switched Network (DSN) testing is on the Telecommunications Switched Services Interoperability website at http://jitc.fhu.disa.mil/tssi. All associated data is available on the DISA Unified Capabilities Certification Office (UCCO) website located at https://aplits.disa.mil.

6. JITC testing point of contact is Mr. Son Pham, commercial (301) 743-4258. His e-mail address is Son.m.Pham2.civ@mail.mil, mailing address: 3341 Strauss Avenue, Suite 236, Indian Head, Maryland 20640-5149. The UCCO Tracking Number (TN) is 1009501.

FOR THE COMMANDER:

3 Enclosures a/s

for RICHARD A MEADOR
Chief
Battlespace Communications Portfolio

Distribution (electronic mail):
Joint Staff J-6
Joint Interoperability Test Command, Liaison, TE3/JT1
Office of Chief of Naval Operations, CNO N6F2
Headquarters U.S. Air Force, Office of Warfighting Integration & CIO, AF/XCIN (A6N)
Department of the Army, Office of the Secretary of the Army, DA-OSA CIO/G-6 ASA (ALT), SAIS-IOQ
U.S. Marine Corps MARCORSYSCOM, SIAT, MJI Division I
DOT&E, Net-Centric Systems, and Naval Warfare
U.S. Coast Guard, CG-64
Defense Intelligence Agency
National Security Agency, DT
Defense Information Systems Agency, TEMC
Office of Assistant Secretary of Defense (NII)/DoD CIO
U.S. Joint Forces Command, Net-Centric Integration, Communication, and Capabilities Division, J68
HQUSAISEC, AMSEL-IE-IS

ADDITIONAL REFERENCES

(c) Office of the Assistant Secretary of Defense, "Department of Defense Unified Capabilities Requirements 2008, Change-1," 22 January 2010
(d) Joint Interoperability Test Command Document, "Unified Capabilities Interoperability Test Plan," 4 February 2010
(e) Joint Interoperability Test Command, "Information Assurance (IA) Assessment of Fujitsu FLASHWAVE 9500, Software Release version 4.1.4, (TN: 1009501)," 19 January 2011

(This page intentionally left blank.)

CERTIFICATION TESTING SUMMARY

1. SYSTEM TITLE. Fujitsu FLASHWAVE 9500, Fixed Network Element (F-NE), with Software Release version 4.1.4

2. SPONSOR. Mr. Steve Pursell, Program Manager, HQUSAISEC, AMSEL-IE-IS, Building 53301, Fort Huachuca, AZ, 85613, e-mail Steven.D.Pursell.civ@mail.mil

3. SYSTEM POC. Ms. Cathy Simon, Fujitsu, Telecom Parkway, Richardson, TX 75082, e-mail: cathy.simon@us.fujitsu.com

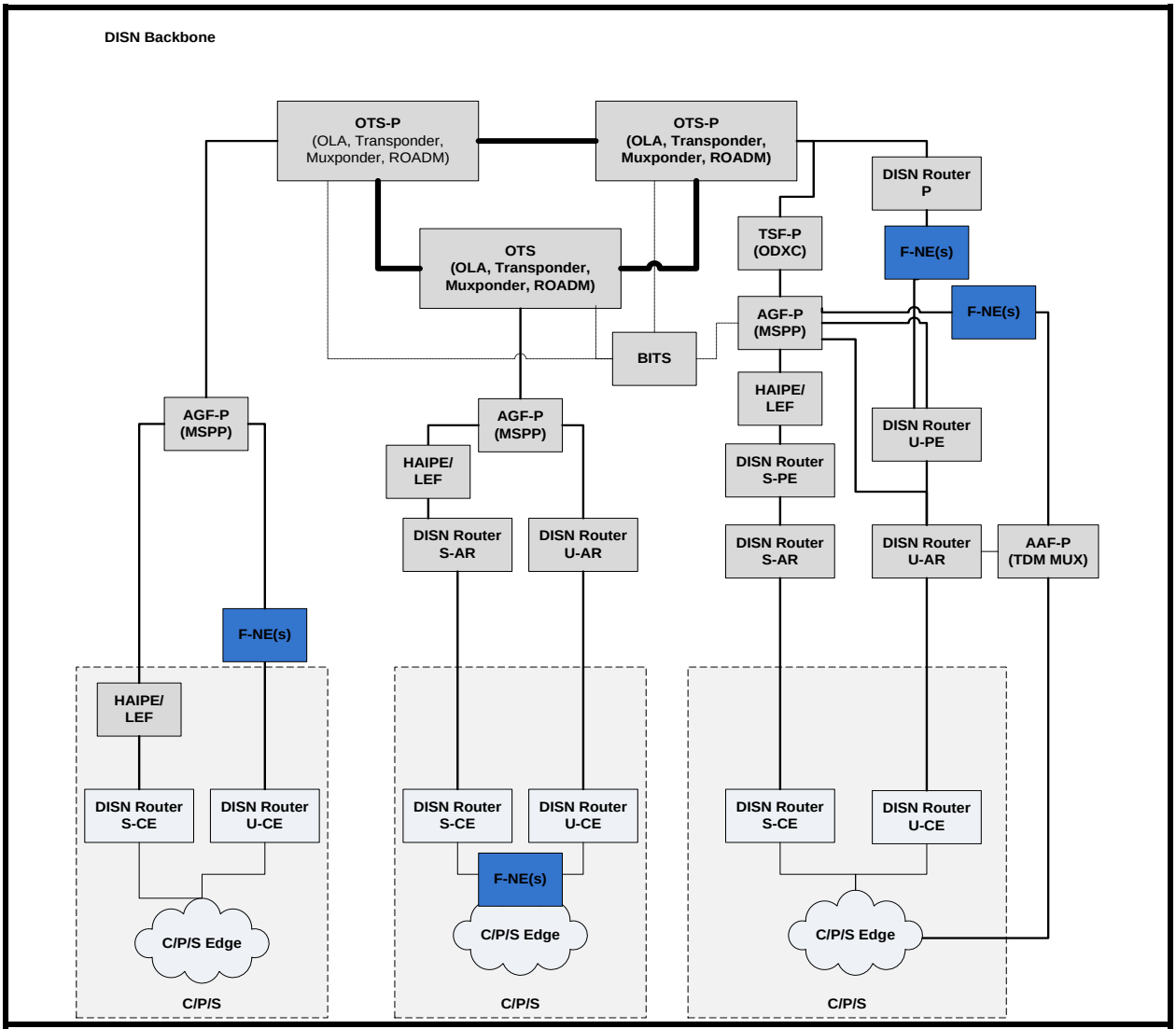
4. TESTER. Joint Interoperability Test Command (JITC), Indian Head, Maryland.

5. SYSTEM DESCRIPTION. The Fujitsu FLASHWAVE 9500, hereinafter referred to as the System Under Test (SUT), is a Packet Optical Network Platform with Ethernet Packet Transport, Optical Digital Cross Connect, and Dense Wavelength Division Multiplexing (DWDM)-based Reconfigurable Optical Add-Drop Multiplexor (ROADM) features with Software Release 4.1.4.

The NetSmart 500 Element Management System (EMS) Software Release 4.4.0 is a Windows-based craft interface tool. The NetSmart 500 software supports graphical shelf views, equipment and facility provisioning, alarm surveillance, software downloading, remote memory backup and remote memory restore capabilities, and cross-connect provisioning. It is only used for configuration purposes and therefore is not certified as a part of the SUT.

The NetSmart 1500 Network Management System (NMS) Software Release 7.0 provides a full suite of network and element management features that enables turn up of Ethernet, Wavelength Division Multiplexing, Synchronous Digital Hierarchy, and Synchronous Optical Transport Network (SONET) services. It is only used for configuration purposes and therefore is not certified under the SUT.

6. OPERATIONAL ARCHITECTURE. JITC tested the SUT under the F-NE Unified Capabilities Requirements (UCR) product category. A high-level Defense Information System Network (DISN) node architecture, as depicted in Figure 2-1, displays the F-NE device. The SUT as F-NE can be deployed to transport DISN services in the Wide Area Network (WAN) and on a camp, post, or station within the Local Area Network (LAN) infrastructure. The SUT solution meets UCR requirements and can be used to augment WAN or LAN infrastructures.



LEGEND:

AAF-P	Access Aggregation Function Product	ODXC	Optical Digital Cross Connect
AGF-P	Access Grooming Function Product	OLA	Optical Line Amplifier
AR	Aggregation Router	OTS-P	Optical Transport System Product
ATM	Asynchronous Transfer Mode	P	Provider Router
BITS	Building Integrated Timing Supply	ROADM	Reconfigurable Optical Add and Drop Multiplexer
CE	Customer Edge Router	S-AR	Secret Aggregation Router
C-PE	Classified Provider Edge Router	S-CE	Secret Customer Edge Router
C/P/S	Camp, Post, or Station	S-PE	Secret Provider Edge Router
DISN	Defense Information System Network	TDM	Time Division Multiplexing
F-NE	Fixed Network Element	T-PE	Transport Provider Edge Router
HAIPE	High Assurance Internet Protocol Encryptor	TSF-P	Transport Switch Function Product
LEF	Link Encryption Family	U-AR	Unclassified Aggregation Router
MSPP	Multi-Service Provisioning Platform	U-CE	Unclassified Customer Edge Router
MUX	Multiplexer	U-PE	Unclassified Provider Edge Router

Figure 2-1. DISN Architecture

7. INTEROPERABILITY REQUIREMENTS. The interface, Capability Requirements (CR), Functional Requirements (FR), Information Assurance (IA), and other requirements for F-NE products are established by Sections 5.4 and 5.9 of the Department of Defense (DoD) UCR 2008, Change 1.

7.1 Interfaces. The F-NE products use its interfaces to connect to LAN or DISN WAN infrastructure. The threshold requirements for interfaces specific to the F-NE products are listed in Table 2-1.

Table 2-1. F-NE Interface Requirements

Interface	Critical (See note 1)	UCR Ref (UCR 2008, Change 1)	Threshold CR/FR (See note 2)	Criteria	Remarks
Ingress (LAN side)					
Analog	No	5.9.3.2.1	1, 2, and 4	Meet minimum CR/FRs and interface standards.	Provides access to local infrastructure.
Serial	No	5.9.2.3.2	1, 2, and 4		
BRI ISDN	No	5.9.2.3.3	1, 2, and 4		
DS1	No	5.9.2.3.4	1, 2, 3, and 4		
E1	No	5.9.2.3.5	1, 2, 3, and 4		
DS3	No	5.9.2.3.6	1, 2, 3, and 4		
OC-X	No	5.9.2.3.8	1, 2, 3, and 4		
IP (Ethernet)	No	5.9.2.3.9	1, 2, 4, and 7		
Egress (WAN side)					
Serial	No	5.9.2.3.2	1, 2, 3, and 4	Meet minimum CR/FRs and interface standards.	Provides access to local infrastructure.
DS1	No	5.9.2.3.4	1, 2, 3, and 4		
E1	No	5.9.2.3.6	1, 2, 3, and 4		
DS3	No	5.9.2.3.6	1, 2, 3, and 4		
OC-X	No	5.9.2.3.8	1, 2, 3, and 4		
IP (Ethernet)	No	5.9.2.3.9	1, 2, 4, and 7		
DLoS	No	5.9.2.3.9	1, 2, 3, 4, and 5		
NM					
10Base-X	Yes	5.3.2.4.4	8	Meet minimum CR/FRs and interface standards.	Provides access to local infrastructure.
100Base-X	Yes	5.3.2.4.4	8		

NOTES:
1. UCR does not specify any minimum interfaces.
2. CR/FR requirements are contained in Table 2-2. CR/FR numbers represent a roll-up of UCR requirements.

LEGEND:

100Base-X	100 Mbps Ethernet generic designation	IP	Internet Protocol
10Base-X	10 Mbps Ethernet generic designation	ISDN	Integrated Services Digital Network
BRI	Basic Rate Interface	LAN	Local Area Network
CR	Capability Requirement	Mbps	Megabits per second
DLoS	Direct Line of Sight	NM	Network Management
DS1	Digital Signal Level 1 (1.544 Mbps)	OC-X	Optical Carrier - X (OC-3, OC-12, etc.,)
DS3	Digital Signal Level 3 (44.736 Mbps)	SUT	System Under Test
E1	European Interface Standard (2.048 Mbps)	UCR	Unified Capabilities Requirements
F-NE	Fixed Network Element	WAN	Wide Area Network
FR	Functional Requirement		

7.2 CR and FR. The F-NE products have required and conditional features and capabilities that are established by Section 5.9 of UCR. The SUT does not need to provide non-critical (conditional) features and capabilities. If they are present, however, they must function according to the specified requirements. Table 2-2 lists the features and capabilities and their associated requirements for the SUT products. Table 3-1 of Enclosure 3 provides detailed CR/FR requirements.

Table 2-2. SUT CRs and FRs

CR/FR ID	Capability/Function	Applicability (See note)	UCR Ref (UCR 2008, Change 1)	Criteria	Remarks
1	**General NE Requirements**				
	General Requirements	Required	5.9.2.1	Meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 of Enclosure 3.	
	Alarms	Required	5.9.2.1.1		
	Congestion Control & Latency	Required	5.9.2.1.2		
2	**Compression**				
	G.726	Conditional	5.9.2.2	Meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 of Enclosure 3.	
	G.728	Conditional	5.9.2.2		
	G.729	Conditional	5.9.2.2		
3	**Interface Requirements**				
	Timing	Required	5.9.2.3.7	Meet UCR requirements.	Applicable to TDM interfaces
4	**Device Management**				
	Management Options	Required	5.9.2.4.1	Meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 of Enclosure 3.	
	Fault Management	Conditional	5.9.2.4.2		
	Loop-Back Capability	Conditional	5.9.2.4.3		
	Operational Configuration Restoral	Required	5.9.2.4.4		
5	**DLoS**				
	DLoS Transport	Conditional	5.9.2.4.5	Meet UCR DLoS requirements.	
6	**IPv6 Requirements**				
	Product Requirements	Required	5.3.5.4	Meet UCR IPv6 requirements.	
7	**NM Requirements**				
	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Meet applicable UCR requirements. Detailed requirements and associated criteria are provided in Table 3-1 of Enclosure 3.	
	General Management Requirements	Required	5.3.2.17.2		

Table 2-2. NE CRs and FRs (continued)

NOTE: Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.

LEGEND:

ADPCM	Adaptive Differential Pulse Code Modulation	ITU-T	ITU Telecommunications Union - Telecommunications Sector
CR	Capabilities Requirement	Kbps	Kilobits per second
CS-ACELP	Conjugate Structure Algebraic Code-Excited Linear Prediction	LD-CELP	Low Delay Code Excited Linear Prediction
DLoS	Direct Line of Sight	NE	Network Element
FR	Functional Requirement	NM	Network Management
G.726	ITU-T speech codec for ADPCM (32 Kbps)	NMS	Network Management System
G.728	ITU-T speech codec for LD-CELP (16 Kbps)	SUT	System Under Test
G.729	ITU-T speech codec for CS-ACELP (8 Kbps)	TDM	Time Division Multiplexing
ID	Identification	UCR	Unified Capabilities Requirements
IPv6	Internet Protocol version 6	VVoIP	Voice and Video over Internet Protocol

7.3 Other. The SUT was originally submitted as an Optical Transport System (OTS) and a Transport Switch Function (TSF) via the Unified Capabilities Certification Office process but based on Defense Information Systems Agency (DISA) guidance received 18 January 2012, this product was re-evaluated as a F-NE. The SUT also supports OTS and TSF features. JITC tested the SUT's functionalities and capabilities. Tables 2-3 and 2-4 lists these requirements on the Other Requirements Section. The SUT with the designated interfaces can be used to interconnect the DISN WAN infrastructure.

Table 2-3. Other SUT Interface Requirements

Interface	Status	Remarks
10 GbE LAN	Certified	Met commercial interface standards and sponsor information exchanges.
10 GbE-WAN	Certified	
OSC	Certified	

NOTE: The threshold CRs/FRs provides a high-level overview of applicable UCR requirements. For detailed applicability of UCR requirements, refer to Enclosure 3.

LEGEND:

CR	Capability Requirements	OSC	Optical Supervisory Channel
FR	Functional Requirement	SUT	System Under Test
GbE	Gigabit Ethernet	UCR	Unified Capabilities Requirements
LAN	Local Area Network	WAN	Wide Area Network

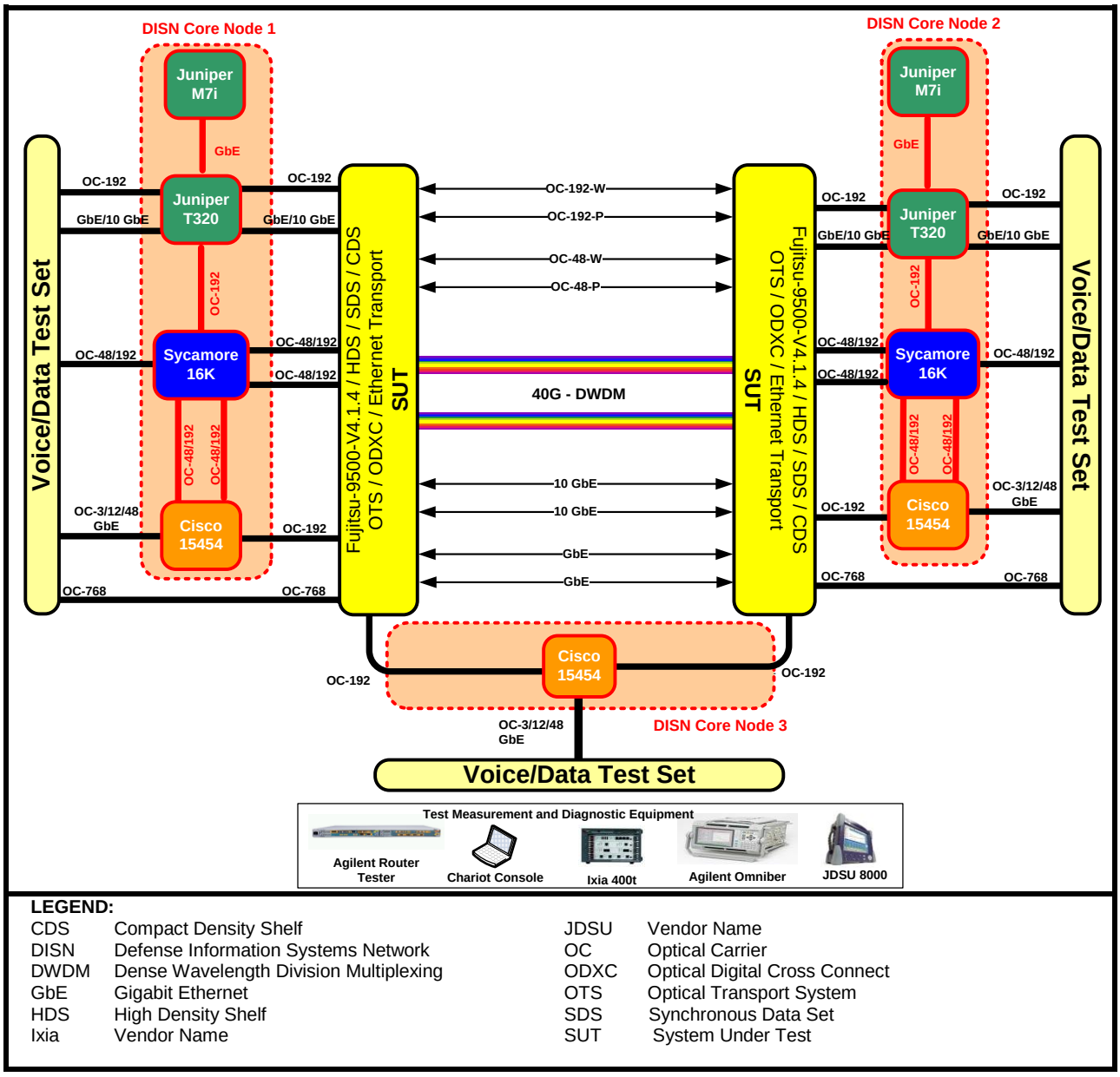
Table 2-4. Other CR/FR Requirements

CR/FR ID	Capability/Function	Applicability	UCR Ref (UCR 2008, Change 1)	Criteria	Remarks
Other Requirements					
8	**Requirements Applicable to all OTS Elements**				
	Overall Requirements	Conditional	5.5.3.2.2.1	Meet Sponsor requirements	
	Performance Requirements	Conditional	5.5.3.2.2.2		
	Reliability and Quality Assurance	Conditional	5.5.3.2.2.2.1		
	Common Physical Design Requirements	Conditional	5.5.3.2.2.3		
	Protection and Restoration	Conditional	5.5.3.2.2.4		
	Optical Amplifier Requirements				
	OLA Physical Design Requirements	Conditional	5.5.3.2.3.1	Meet Sponsor requirements	
	Muxponder Requirements				
	Muxponder	Conditional	5.5.3.2.4	Meet Sponsor requirements	
	Transponder Requirements				
	Transponder	Conditional	5.5.3.2.5	Meet Sponsor requirements	
	Interface Requirements	Conditional	5.5.3.2.5.1		
	ROADM Requirements				
	ROADM Requirements	Conditional	5.5.3.2.6	Meet Sponsor requirements	
	ROADM Specific Physical Design Requirements	Conditional	5.5.3.2.6.1		
	Requirements Common to Transponder and ROADM				
	Framed Formats	Conditional	5.5.3.2.7.1	Meet Sponsor requirements	
	Unframed Formats	Conditional	5.5.3.2.7.2		
	Optical Supervisory Channel Requirements				
	Optical Supervisory Channel	Conditional	5.5.3.2.8	Meet Sponsor requirements	
TSF Requirements					
9	OTS Standards Compliance	Required	5.5.3.4.2	Meet Sponsor requirements	
	TSF SONET/SDH	Required	5.5.3.4.3		
	TSF Ethernet	Required	5.5.3.4.3.1		
	TSF Framing Requirements	Required	5.5.3.4.4		
	TSF Switch Fabric	Required	5.5.3.4.4		
	TSF Performance	Required	5.5.3.4.6		
	General Link Protection	Required	5.5.3.4.7		
	Linear Protection	Required	5.5.3.4.8		
	Ring Protection	Required	5.5.3.4.9		
	Fault management	Required	5.5.3.4.10		
	Performance Management	Required	5.5.3.4.11		
	EMS	Required	5.5.3.4.12		
	Physical Design	Required	5.5.3.4.13		

LEGEND:

CR	Capabilities Requirement	ROADM	Reconfigurable Optical Add Drop Multiplexor
EMS	Element Management System	SONET	Synchronous Optical Transport Network
FR	Functional Requirement	SDH	Synchronous Digital Hierarchy
ID	Identification	TSF	Transport Switch Function
OLA	Optical Line Amplifier	UCR	Unified Capabilities Requirements
OTS	Optical Transport System		

8. TEST NETWORK DESCRIPTION. JITC tested the SUT at its Indian Head, Maryland, Advanced Technologies Test bed. Figure 2-2 shows the SUT's Test Configuration.



LEGEND:

CDS	Compact Density Shelf	JDSU	Vendor Name
DISN	Defense Information Systems Network	OC	Optical Carrier
DWDM	Dense Wavelength Division Multiplexing	ODXC	Optical Digital Cross Connect
GbE	Gigabit Ethernet	OTS	Optical Transport System
HDS	High Density Shelf	SDS	Synchronous Data Set
Ixia	Vendor Name	SUT	System Under Test

Figure 2-2. SUT's Test Configuration

9. SYSTEM CONFIGURATION. Table 2-5 lists the tested SUT equipment shown in Figure 2-2, Table 2-6 lists the Non-SUT equipment used to test the SUT, and Table 2-7 lists the test equipment used to generate voice, Synchronous Optical Network, and Internet Protocol (IP) traffic.

Table 2-5. Hardware/Software Tested SUT Equipment

Platform	Software Release	UC Product Type
Fujitsu FLASHWAVE 9500	4.1.4	F-NE
Sub-Components		
Component Name	**Software Release**	**Function**
Fujitsu NetSmart 500	4.4.0	Graphical Craft Interface
Fujitsu NetSmart 1500	7.0	Network Management System
SUT-Equipments List		
Item/Card Name	**Part Number**	**Number of Items**
240Gb/s SONET and Packet Switch Fabric	FC9565SF21	2
10GbE Packet Engine Plus Mapper (HO/DS3 + LO/DS1) unit	FC9565PEA2	1
10 GbE/OTN 88-channel tunable unit	FC9565TGD1	2
40GbE 88 channel tunable unit	FC9565TCA1	2
8 x 1 WSS 50 GHz WSS unit	FC9565W8C1	4
Short Reach Amplifier	FC9565ASC1	2
44 Channel C-Band Mux/Demux unit	FC9565MAB1	4
DCM TW-RS- 150 ps/nm (38 km)	FC9565DC15	2
DCM ELEAF -150 ps/nm (36 km)	FC9565DB15	1
DCM ELEAF -300 ps/nm (71 km)	FC9565DB30	1
DCM TW-RS -250 ps/nm (63 km)	FC9565DC25	1
OUPSR Module	FC9565LGB1	1
Short Reach Amplifier	FC9565ASC1	2
Shelf OSP Hardened, redundant management and Intercard Communications (across card LAG, LDxx, HDxx), I/O Panel Support, Enhanced	FC9695CDS2	3
OC- 3- 1310 nm SR/IR, SMF/MMF LC Connector, sys gain 13 dB (2 km on MMF)	FC95700020	2
OC- 3-1310 nm LR, LC Connector, sys gain 29 dB	FC95700030	1
OC- 3-1550 nm LR-2, LC Connector, sys gain 29 dB	FC95700040	1
OC- 12- 1310 nm IR, LC Connector, sys gain 13 dB	FC95700050	2
OC- 12-1310 nm LR, LC Connector, sys gain 25 dB	FC95700060	1
OC- 12-1550 nm LR-2, LC Connector, sys gain 25 dB	FC95700070	1
OC- 48- 1310 nm SR, LC Connector, sys gain 8 dB (3.4 km Dispersion Limit)	FC95700120	2
OC- 48- 1310 nm IR, LC Connector, sys gain 13 dB	FC95700130	1
OC- 48-1310 nm LR-1, LC Connector, sys gain 25 dB	FC95700140	1
OC- 48-1550 nm LR-2, LC Connector, sys gain 26 dB	FC95700150	1
GigE or Fiber Chnl -850 nm SR, MMF, LC Connector, Sys gain 7 dB	FC95705030	1
GigE or Fiber Chnl -1310 nm LR, SMF, LC Connector, sys gain 11.5 dB	FC95705040	8
GigE or Fiber Chnl -1550 nm ZX, SMF, LC Connector, up to 90 km, Rls 6.1	FC95705051	1
100Base-FX, MMF or SMF, 2 Km, Adds Equip Diagnostics to 100Bx MMF SFP	FC95705081	1
100Base-LX, 10 km, 1310 nm	FC95705090	4
10 GE, 850 nm, SR-1, 2 km XFP module (I-TEMP)	FC9573E410	4
10 GE, IR-1, 40 km XFP module (I-TEMP)	FC9573E420	1
Combo OC-3/12/48/GE card (8-port)	FC9565CMD1	4
Dispersion Compensation Module - 10 km - SMF	FC9565DA02	2
20-port Gigabit Ethernet Card (SFP pluggable)	FC9565EGS1	1
External Passive ROADM Shelf - supports 88 channels	FC9565ES40	6
10 GE NBO Card (double width)	FC9565ETA1	2
2-port 10G Ethernet Card (Client XFP pluggable)	FC9565EXX1	1
OUPSR Module	FC9565LGB1	1
44 Channel C-band mux/demux	FC9565MAA1	2
44 Channel C-band mux/demux with interleaver	FC9565MAA2	4
OC-192 SONET card (2-port)	FC9565S9B1	4
480 Gbps SONET and Packet switch fabric	FC9565SF11	4
G.709 OTU-2 NBO card using tunable laser (1-port)	FC9565STA2	2
10Gig Universal Transponder (Client XFP Pluggable)	FC9565TBA1	6
8x1 WSS 100 GHz ready (double width)	FC9565W8A1	4
OC- 3 IR-1	FC95700021	4

Table 2-5. Tested SUT Equipment (continued)

Item/Card Name	Part Number	Number of Items
OC-12, IR-1 SFP	FC95700051	4
OC- 48 SR-1	FC95700080	10
Multi-rate (OC- 3/12/48, GbE) SR (GigE LX/LX10)	FC95700160	1
Multi-rate (OC- 3/12/48, GbE) IR-1(GigE LX/LX10)	FC95700170	1
STM-1e	FC95700200	2
OC- 48 NBO SFP - 1530.33 nm, 195.9 THz, ITU Channel 59	FC95704AAC	2
OC- 48 NBO SFP - 1560.61 nm, 192.1 THz, ITU Channel 21	FC95704ABS	2
1000BaseSX, MMF 2 km SFP	FC95705000	4
100Base-FX	FC95705082	2
100Base-LX10	FC95705092	2
1000Base-LX10	FC95705200	2
10/100/1000Base-T (copper)	FC95705210	2
Multi-rate CWDM (OC- 3/12/48/GE) 1610 nm	FC9570B40A	1
Multi-rate CWDM (OC- 3/12/48/GE) 1470 nm	FC9570B40H	1
Mulit-rate OC-192 SR-1/10Base-LR XFP mod	FC95731410	3
XFP1-D410, Multi-rate OC- 192-SR1/10GBase-LRLW	FC9573D410	3
Heat Baffle	FC9682HSW2	5
MPC1 with preloaded R4.1.4 software	PL9500MPC1R0414A	1
MPE1 with preloaded R4.1.4 software	PL9500MPE1R0414A	1
Low-density plug-in unit: twelve 1 GbE electrical ports, twelve 1 GbE optical ports (preloaded with R4.1.4)	PXCDSLDP1R0414A	2
Low-density plug-in unit: two client ports supporting OC-3, OC-12, and GbE; two network ports supporting OC-48 (preloaded with R4.1.4)	PXCDSLDP3R0414A	2
High-density plug-in unit: twelve 100/1000Base-X Ethernet SFP client ports, twelve RJ-45 10/100/1000 Base-T Ethernet client ports, and two 10GbE XFP network ports (preloaded with R4.1.5)	PXCDSHDP1R0414A	2
FW9500 R4.1.4 Master Software CD-ROM	FC9565CR04-I04	1
NETSMART 500, v4.4 software	NS50004-I04	1

LEGEND:

LRLW	Media type, designed for use over dark fiber and connect to SONET equipment	LR	Long Reach
		LX	Long Wavelength
C-Band	wavelength range from 1530–1565 nm	MMF	Multi-Mode Fiber
CD-ROM	Compact Disk-Read Only Memory	MPC	Multi-Path Channel
Chnl	Channel	MPE	Multi Protocol Encapsulation
CWDM	Coarse Wavelength Division Multiplexor	MUX	Multiplexor
dB	Decibel	NBO	Network Build Out
DCM	Digital Carrier Module	NISP	Network Infrastructure Product
DS	Digital Signal	nm	nanometer
ELEAF	Enhanced Large Effective Area Fiber	OC	Optical Carrier
F-NE	Fixed-Network Element	OSP	Open Shortest Path
FW	Flashwave	OTN	Optical Transport Network
FX	Fast Ethernet over Fiber Cable	OTU	Optical Transport Unit
Gb/s	Gigabits per second	OUPSR	Optical Unidirectional Path Switched Ring
GbE	Gigabit Ethernet	PS	Peco second
G	Gigabit	ROADM	Reconfigurable Optical Add-Drop Multiplexor
GHz	Gigahertz	SDS	Small Density Shelf
Gig	Gigabit	SFP	Small Form-Factor
GigE	Gigabit Ethernet	SMF	System Management Facility
HD	High Density	SONET	Synchronous Optical Transport Network
HO	High Order	SR	Short Reach
I/O	Input/Output	STM	Synchronous Transport Module
IR	Intermediate Reach	SUT	System under Test
I-TEMP	Industrial Temperature	SX	Short Wavelength
ITU	International Telecommunications Union	THz	Terahertz
km	kilometer	TW-RS	True Wave-RS
LAG	Link Aggregation Group	UC	Unified Capabilities
LC	Line Conditioner	WSS	Wavelength Selective Switching
LD	Low Density	XFP	X-Form Factor Pluggable
LO	Low Order	ZX	Long Wavelength Laser

Table 2-6. Non-SUT Equipment

Component	Software Version	Function
Cisco 15454	09.00-008I-17.17	ETH 100T-12-G, OC-3IR-STM-1 SH-1310-8, OC-12IR-STM-4-1310-4, DS-1N-14, G1K-4, OC-192SR/STM-64, OC-48 AS-IR-1310, DS-3N-12E
Sycamore ODXC	7.6.21 Build 0562.26.27.57.14	GPIC2 2 x OC-192/STM-64, GPIC 24 x OC-3-12/STM-1-4IR, GPIC2 8 x OC-48/STM-16, USC - OC-192 LR 2c LIM 1
Juniper T320 Router	9.2.R2.15	4 x FE 100 Base X, 10 x GbE LAN 1000 Base TX, 1x OC-192 SM SR2, 1 x 10GbE LAN, XENPAK
Juniper M7i	10.3.R4.4	4 x GbE LAN

LEGEND:

100Base-X	100 Mbps Ethernet generic designation	OC	Optical Carrier
10Base-X	10 Mbps Ethernet generic designation	ODXC	Optical Digital Cross Connect
DS	Digital Signal	R	Revision
ETH	Ethernet	SR	Short Reach
FE	Fast Ethernet	STM	Synchronous Transport Module
GbE	Gigabit Ethernet	SUT	System Under Test
GPIC	General Purpose Interface Card	TX	Fast Ethernet Twisted Wires
LAN	Local Area Network	USC	Universal Services Card
LR	Long Reach	X	Place holder for FX or TX

Table 2-7. Test Equipment

Manufacture	Type	Port Type	Software Version
Anritsu	Tunics Plus – Tunable Laser	C-Band	1.00
Agilent	Optical Tester	1550 nm	A.06.01
		1310 nm	
	Router Tester 900	OC-3/OC-12 /POS	6.11
		OC-48 Multilayer	
		1000 Base X	
Ixia	Traffic generator	10GbE	5
		LM1000STX	
Digital Lightwave	Optical Wavelength Manager	Monitor Ports	2.4.0
Agilent	Rack Mounted Router Tester 900	10GbE LAN/WAN	6.11
		10/100/1000 Base-T	
		1000 Base-X	
		OC-48c POS	
		OC-3/12/POS	
JDSU	T-Berd 8000	OC-192 POS	6.11
		DSU	6.4
		10/100/1000	
		OC-3-12	
		OC-192	
		STM-1/STM-4/STM-16/STM-64	

LEGEND:

10/100/1000Base-T	Mbps Ethernet generic designation	LAN	Local Area Network
1000Base-X	1000 Mbps Ethernet generic designation	nm	nanometer
		OC	Optical Carrier
DSU	Data Services Unit	POS	Packet Over Synchronous Optical Network
GbE	Gigabit Ethernet	STM	Synchronous Transport Module
Ixia	Vendor Name	STX	Ixia Product Name
JDSU	Vendor Name	WAN	Wide Area Network

10. TEST LIMITATIONS. None

11. INTEROPERABILITY EVALUATION RESULTS. The SUT meets the critical interoperability requirements for F-NE and JITC certifies its joint use within the DISN. Additional discussion regarding specific testing results is contained in subsequent paragraphs.

11.1 Interfaces. The SUT's interface status is provided in Table 2-8.

Table 2-8. SUT F-NE Interface Requirements Status

Interface		Critical (See note)	UCR Ref (UCR 2008, Change 1)	Status	Remarks
NE	Analog	No	5.9.3.2.1	NA	Not Supported By The SUT.
	Serial	No	5.9.2.3.2	NA	Not Supported By The SUT.
	BRI ISDN	No	5.9.2.3.3	NA	Not Supported By The SUT.
	DS1	No	5.9.2.3.4	NA	Not Supported By The SUT.
	E1	No	5.9.2.3.5	NA	Not Supported By The SUT.
	DS3	No	5.9.2.3.6	NA	Not Supported By The SUT.
	OC-X	No	5.9.2.3.8	Certified	SUT met requirements for specified interfaces. OC-48/STM-16; OC-192/STM-64; and OC-768/STM 256.
	IP (Ethernet) 10/100/1000 and 10GbE	No	5.9.2.3.9	Certified	SUT met requirements for specified interfaces.
NM	10Base-X	Yes	5.3.2.4.4	Certified	SUT met requirements for specified interfaces.
	100Base-X	Yes	5.3.2.4.4	Certified	

NOTE: UCR does not specify any minimum interfaces. The SUT must minimally provide one of the listed ingress and egress interfaces specified.

LEGEND:

100Base-X	100 Mbps Ethernet generic designation	ISDN	Integrated Services Digital Network
10Base-X	10 Mbps Ethernet generic designation	Mbps	Megabits per second
BRI	Basic Rate Interface	NA	Not Applicable
DS1	Digital Signal Level 1 (1.544 Mbps)	NE	Network Element
DS3	Digital Signal Level 3 (44.736 Mbps)	NM	Network Management
E1	European Interface Standard (2.048 Mbps)	OC-X	Optical Carrier - X (OC-3, OC-12, etc.,)
F-NE	Fixed Network Element	STM	Synchronous Transport Module
GbE	Gigabit Ethernet	SUT	System Under Test
IP	Internet Protocol	UCR	Unified Capabilities Requirements

11.2 CR and FR. The SUT's CR/FR statuses are listed in Table 2-9. The detailed CR/FR requirements are provided in Table 3-1 of the System FRs and CRs (Enclosure 3).

Table 2-9. SUT CRs and FRs Status

CR/FR ID	Capability/Function	Applicability (see Note)	UCR Ref (UCR 2008, Change 1)	Status	Remarks
F-NE CR/FR					
1	**General NE Requirements**				
	General Requirements	Required	5.9.2.1	Met	
	Alarms	Required	5.9.2.1.1	Met	
	Congestion Control & Latency	Required	5.9.2.1.2	Met	
2	**Compression**				
	G.726	Conditional	5.9.2.2	NA	Not supported by SUT.
	G.728	Conditional	5.9.2.2	NA	Not supported by SUT.
	G.729	Conditional	5.9.2.2	NA	Not supported by SUT.
3	**Interface Requirements**				
	Timing	Required	5.9.2.3.7	Met	
4	**Device Management**				
	Management Options	Required	5.9.2.4.1	Met	
	Fault Management	Conditional	5.9.2.4.2	Met	
	Loop-Back Capability	Conditional	5.9.2.4.3	Met	
	Operational Configuration Restoral	Required	5.9.2.4.4	Met	
5	**DLoS**				
	DLoS Transport	Conditional	5.9.2.4.5	NA	Not supported by SUT.
6	**IPv6 Requirements**				
	Product Requirements	Required	5.3.5.4	Met	SUT is a Layer-2 device and transports IPv4 and IPv6 traffic transparently.
7	**NM Requirements**				
	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Met	
	General Management Requirements	Required	5.3.2.17.2	Met	

NOTE: Annotation of 'required' refers to high-level requirement category. Applicability of each sub-requirement is provided in Enclosure 3.

LEGEND:

ADPCM	Adaptive Differential Pulse Code Modulation	IPv6	Internet Protocol version 6
CR	Capabilities Requirement	ITU-T	International Telecommunications Union - Telecommunications Sector
CS-ACELP	Conjugate Structure Algebraic Code-Excited Linear Prediction	Kbps	Kilobits per second
DLoS	Direct Line of Sight	LD-CELP	Low Delay-Code Excited Linear Prediction
F-NE	Fixed-Network Element	NA	Not Applicable
FR	Functional Requirement	NE	Network Element
G.726	ITU-T speech codec for ADPCM (32 Kbps)	NM	Network Management
G.728	ITU-T speech codec for LD-CELP (16 Kbps)	NMS	Network Management System
G.729	ITU-T speech codec for CS-ACELP (8 Kbps)	SUT	System Under Test
ID	Identification	UCR	Unified Capabilities Requirements
IPv4	Internet Protocol version 4	VVoIP	Voice and Video over Internet Protocol

a. General NE Requirements

(1) General Requirements. In accordance with (IAW) UCR 2008, Change 1, Section 5.9.2.1 all NEs shall meet the following general requirements and conditions:

(a) The introduction of an NE(s) shall not cause the End-to-End (E2E) average Mean Opinion Score (MOS) to fall below 4.0 as measured over any 5-minute

time interval. The SUT met the MOS requirement as measured using test equipment and simulated voice information exchanges.

(b) The introduction of an NE(s) shall not degrade the E2E measured Bit Error Rate (BER) to no more than .03 percent from the baseline minimum E2E digital BER requirement, which is not more than one error in $1x10^9$ bits (averaged over a 9-hour period). The SUT met the requirement as measured using test equipment and simulated information exchanges.

(c) The introduction of an NE(s) shall not degrade secure transmission for secure end devices as defined by UCR 2008, Change 1, Section 5.2.12.6, and DoD Secure Communications Devices. JITC tested secure information exchanges by using DoD Secure Communications Devices such as Secure Telephone Unit/Secure Terminal Equipment devices with no noted issues.

(d) The NE(s) shall support a minimum modem transmission speed of 9.6 kbps across the associated NE(s). JITC tested this information exchange by using a modem and simulated information exchange with no noted issues.

(e) The NE(s) shall support a minimum facsimile transmission speed of 9.6 kbps across the associated NE(s). JITC tested this information exchange by using a facsimile and simulated information exchanges with no noted issues.

(f) The NE shall transport all call control signals transparently on an E2E basis. JITC tested this information exchange by using an actual call control signals via a Private Branch Exchange Trunk 1 calls and simulated information exchanges with no noted issues.

(2) Alarms. The NE shall provide the capability of detecting a Carrier Group Alarm (CGA). NEs that support Internet Protocol (IP) ingress/egress traffic either as inbound or outbound NE traffic and/or transport between NE(s) shall support one or more of the following routing protocols: Link-State and/or Distance-Vector, such that the NE can notify the IP network (e.g., LAN and Metropolitan Area Network) the condition of its link state for transporting ingress IP traffic, namely operational or down. The SUT is a Layer-2 device and it passes all the routing protocols, IP link states transparently between connecting end equipments, and it propagates all CGA with no noted issues. In addition, it provides loss of signal alarm in case of loss of connectivity events for connecting end equipments.

(3) Congestion Control and Latency. IAW UCR 2008, the NE shall ensure that congestion and latency between paired NEs does not affect DISN calls in progress or subsequent calls. Call congestion and latency requirements are as follows:

(a) Time Division Multiplexing (TDM) Transport. The SUT is a Layer-2 device and SUT provides transparent TDM Transport. Therefore, the following TDM

transport requirements are not applicable to the SUT. These requirements are the responsibility of connecting end equipments.

1. A dynamic load control signal (e.g., contact closure) shall be provided to the DISN switch.

2. Congestion is not possible in the NE by nature of its functioning (e.g., a TDM multiplexer or transcoder).

3. A software capability in limiting the provisioning the ingress and egress interfaces making congestion impossible even under the worst congestion scenario. This can be done by limiting the bearer or aggregate provisioning.

4. TDM Transport Latency. The addition of NEs with TDM transports shall not increase the one-way latency per NE pair when measured from end to end over any 5-minute period specified as follows:

a. TDM ingress G.711 (non-secure calls) to non-transcoding G.711 TDM egress shall not increase delay more than 10 ms per NE pair as measured E2E.

b. TDM ingress G.711 (non-secure calls) to transcoding TDM egress with compression codecs shall not increase delay by more than 100 ms per NE pair as measured E2E.

c. TDM ingress G.711 (secure calls) to non-transcoding TDM egress G.711 shall not increase delay by more than 50 ms per NE pair as measured E2E.

d. TDM ingress G.711 (secure calls) to transcoding TDM egress with compression codecs shall not increase delay by more than 250 ms per NE pair as measured E2E.

(b) IP Transport. The NE(s) using IP transport shall implement IP congestion control. Congestion may be controlled by using Differentiated Services, which shall be capable of providing preferential treatment for call congestion over other media types and a capability to limit the provisioning of input, and output interfaces so congestion is impossible under the worst transport congestion scenario. The IP interface parameters subject to ingress/egress requirements shall be met. The SUT is a Layer-2 device and it passes all IP traffic transparently, therefore, none of the above IP transport requirement is applicable to the SUT, instead those are responsibility of connecting end equipments.

(c) Direct Line of Sight (DLoS) Transport. The SUT does not provide DLoS Transport.

b. Compression. The SUT does not support Compression.

c. Interface Requirements. Timing. The NE shall be able to derive timing signal from an internal source, an incoming digital signal, or an external source. This requirement applies to TDM interfaces only; IP interfaces do not need to meet this requirement.

d. Device Management. The SUT shall provide the following device management functions:

(1) Management Options. The NE devices are to be managed by at least one of the following:

(a) A front or back panel and/or external console control capability shall be provided for local management and SUT supports only external console control capability. The SUT provides an external console capability.

(b) Remote monitoring and management by the Advanced DSN Integrated Management Support System (ADIMSS). JITC did not verify management of the SUT by ADIMSS.

(2) Fault Management. The SUT may (conditional) report any failure of self-test diagnostic function on non-active and active channels on a noninterference basis to the assigned NMS. JITC verified this conditional capability via Network Management (NM) testing.

(3) Loop-Back Capability. This requirement applies to TDM interfaces only; the SUT does provide loop-back capabilities via its all interfaces.

(4) Operational Configuration Restoral. Loss of power should not remove configuration settings. The SUT shall restore to the last customer-configured state before the power loss, without intervention when power is restored. JITC verified this capability via NM testing.

e. DLoS. DLoS Transport. The SUT does not provide DLoS Transport.

f. Internet Protocol version 6 (IPv6) Requirements. The SUT must meet UCR 2008, Change 1, Section 5.3.5.4 IPv6 requirements for Network Appliance/Simple Server (NA/SS). The SUT is a Layer-2 device and transports Internet Protocol version 4 and IPv6 traffic transparently so requirements specific relating to layer 3 do not apply.

g. NM Requirements. JITC verified the following NM requirements by connecting the NMS to the SUT via all required interfaces and in addition verified via utilization of NMS for performing test configurations, for performing alarms monitoring, and for performing fault management.

(1) Voice and Video over Internet Protocol (VVoIP) NMS Interface Requirements. The physical interface between the Defense Information Systems Agency VVoIP Element Management System (EMS) and the network components (i.e., Local Session Controller, Multifunction Soft Switch, Edge Boundary Controller, Customer Edge Router is a 10/100-Mbps Ethernet interface. The interface will work in either of the two following modes using auto-negotiation: Institute of Electrical and Electronics Engineers (IEEE), Ethernet Standard 802.3, 1993; or IEEE, Fast Ethernet Standard 802.3u, 1995.

(2) General Management Requirements. The SUT must support Simple Network Management Protocol v3 format. A network appliance shall have Operations interfaces that provide a standard means by which management systems can directly or indirectly communicate with and, thus, manage the various network appliances in the DISN. The physical interface between the Local EMS and the VVoIP network components shall be an Ethernet connection IAW UCR 2008, Change 1, paragraph 5.3.2.4.4, VoIP NMS Interface Requirements. The physical interface between the VVoIP EMS and the VVoIP network components shall also be an Ethernet connection IAW UCR 2008, Change 1, paragraph 5.3.2.4.4. There shall be a local craftsperson interface (Craft Input Device for Operations Administration & Management) for all VVoIP network components.

11.3 Other. JITC has conducted additional tests on the SUT. Table 2-10 shows the Additional Interface Requirements under UCR 2008, Change 1, Section 5.5.3.4, and the results**.** The SUT's CR/FR status under OTS and TSF requirements are listed in Table 2-11. The SUT met the minimum UCR 2008, Change 1 References, Section 5.5.3.2 standards for the OTS with the following exceptions:

a. Requirements Applicable to all OTS Elements/Overall Requirements – Sub-Paragraphs: (5.5.3.2.) 2.1.7, 2.1.9, 2.1.10, 2.1.11, 2.1.12,, 2.1.17
b. Requirements Applicable to all OTS Elements/Reliability and Quality Assurance – Sub-Paragraphs: (5.5.3.2.) 2.2.3.38, 2.2.3.44
c. Optical Amplifier Requirements/Optical Line Amplifier Physical Design Requirements – Sub-Paragraphs: (5.5.3.2.) 3.1, 3.3, 3.4, 3.5, 3.14, 3.16, 3.19, 3.20, 3.21, 3.22, 3.23, 3.24, 3.25, 3.26, 3.27
d. Muxponder Requirements/Muxponder – Sub-Paragraphs: (5.5.3.2.) 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.10, 4.11, 4.12
e. Transponder Requirements/Transponder – Sub Paragraphs: (5.5.3.2.) 5.8, 5.12, 5.15
f. Transponder Requirements/Interface Requirements – Sub Paragraph: (5.5.3.2.) 5.1.7
g. ROADM Requirements/ROADM Requirements – Sub-Paragraphs: (5.5.3.2.) 6.2, 6.3, 6.4, 6.5, 6.10, 6.11, 6.12, 6.15, 6.16, 6.22
h. Requirements Common to Transponder and ROADM/Framed Formats – Sub-Paragraphs: (5.5.3.2.) 7.1.5, 7.1.6, 7.1.7
i. Requirements Common to Transponder and ROADM/Unframed Formats – Sub-Paragraphs: (5.5.3.2.) 7.2.1, 7.2.2

j. Optical Supervisory Channel Requirements/Optical Supervisory Channel – Sub-Paragraphs: (5.5.3.2.) 8.5, 8.9
k. Optical Supervisory Channel Requirements/OTS Standard Compliance – Sub-Paragraph: (5.5.3.2.) 9.4, 9.6

The SUT met the minimum standards for the TSF following UCR 2008, Change 1 References, Section 5.5.3.3, with the following exceptions:

a. TSF Requirements/TSF SONET/SDH – Sub-Paragraphs: (5.5.3.3.) 2.1, 2.3, 2.6, 2.9, 2.10, 2.12
b. TSF Requirements/TSF Ethernet – Sub-Paragraph: (5.5.3.3.) 3.16
c. TSF Requirements/TSF Switch Fabric – Sub-Paragraphs: (5.5.3.3.) 5.2, 5.5
d. TSF Requirements/General Link Protection – Sub-Paragraphs: (5.5.3.3.) 7.1, 7.2
e. TSF Requirements/Linear Protection – Sub-Paragraphs: (5.5.3.3.) 8.5, 8.6, 8.8
f. TSF Requirements/Ring Protection – Sub-Paragraph: (5.5.3.3.) 9.5
g. TSF Requirements/Performance Management – Sub-Paragraph: (5.5.3.3.) 11.3
h. TSF Requirements/EMS – Sub-Paragraphs: (5.5.3.3.) 12.1, 12.2
i. TSF Requirements/Standards Compliance – Sub-Paragraph: (5.5.3.3.) 14.25

The detailed CR/FR requirements are provided in Table 3-2 of Enclosure 3, the System FRs and CRs.

Table 2-10. Additional Interface Requirements Status

Interface	OTS Status	TSF Status	Remarks
10 GbE-LAN	Certified	Certified	Met commercial interface standards and sponsor information exchanges.
10 GbE-WAN	Certified	Certified	
100 GbE-WAN	Not Certified	Not Certified	
OTN OTU-1/OTU-2/OTU-3	Not Tested	Not Tested	
OTN 100 Gbps	Not Certified	Not Certified	
OSC	Certified	NA	

NOTE: The threshold CRs/FRs provides a high-level overview of applicable UCR requirements. For detailed applicability of UCR requirements, refer to Enclosure 3.

LEGEND:

CR	Capability Requirements	OTN	Optical Transport Network
FR	Functional Requirement	OTS	Optical Transport System
GbE	Gigabit Ethernet	OTU	Optical Transport Unit
Gbps	Gigabits per second	TSF	Transport Switch Function
LAN	Local Area Network	UCR	Unified Capabilities Requirements
NA	Not Applicable	WAN	Wide Area Network
OSC	Optical Supervisory Channel		

Table 2-11. Other CRs and FRs

CR/FR ID	Capability/Function	UCR Ref (UCR 2008, Change 1)	Status	Remarks
8	**Requirements Applicable to all OTS Elements**			
	Overall Requirements	5.5.3.2.2.1	Partially Met	See note 1.
	Performance Requirements	5.5.3.2.2.2l	Met	
	Reliability and Quality Assurance	5.5.3.2.2.2.1	Partially Met	See note 2.
	Common Physical Design Requirements	5.5.3.2.2.3	Met	
	Protection and Restoration	5.5.3.2.2.4	Met	
	Optical Amplifier Requirements			
	OLA Physical Design Requirements	5.5.3.2.3.1	Not Met	See note 3.
	Muxponder Requirements			
	Muxponder	5.5.3.2.4	Partially Met	See note 4.
	Transponder Requirements			
	Transponder	5.5.3.2.5	Partially Met	See note 5.
	Interface Requirements	5.5.3.2.5.1	Partially Met	See note 6.
	ROADM Requirements			
	ROADM Requirements	5.5.3.2.6	Partially Met	See note 7.
	ROADM Specific Physical Design Requirements	5.5.3.2.6.1	Met	
	Requirements Common to Transponder and ROADM			
	Framed Formats	5.5.3.2.7.1	Partially Met	See note 8.
	Unframed Formats	5.5.3.2.7.2	Partially Met	See note 9.
	Optical Supervisory Channel Requirements			
	Optical Supervisory Channel	5.5.3.2.8	Partially Met	See note 10.
	OTS Standard Compliance	5.5.3.2.9	Partially Met	See note 11.
9	**TSF Requirements**			
	TSF SONET/SDH	5.5.3.3.2	Partially Met	See note 12.
	TSF Ethernet	5.5.3.3.3	Partially Met	See note 13.
	TSF Framing Requirements	5.5.3.3.4	Met	
	TSF Switch Fabric	5.5.3.3.5	Partially Met	See note 14.
	TSF Performance	5.5.3.3.6	Met	
	General Link Protection	5.5.3.3.7	Partially Met	See note 15.
	Linear Protection	5.5.3.3.8	Partially Met	See note 16.
	Ring Protection	5.5.3.3.19	Partially Met	See note 17.
	Fault management	5.5.3.3.10	Met	
	Performance Management	5.5.3.3.11	Partially Met	See note 18.
	EMS	5.5.3.3.12	Partially Met	See note 19.
	Physical Design	5.5.3.3.13	Met	
	Standards Compliance	5.5.3.3.14	Partially Met	See note 20.

Table 2-11. Other CRs and FRs (continued)

NOTES:

1. SUT does not support 100G transponder, SUT did not meet multiple DWDM span reach requirements, SUT supports only 450km over SMF, 930km over NZDSF for 40G“, SUT does not support any type of 100G interface, SUT supports only 135km length and 35dB spans loss, and SUT does support Pre-dispersion compensation.
2. The OTS shall provide for a minimum of eight user-defined remote control points for external functions but SUT only supports four. The SUT does not support software upgradeability in a modular fashion as required by the UCR.
3. The OTS must support the Raman amplifiers but SUT does not support it, and OTS must support internal Optical Spectrum Analyzer, but SUT does not support it, The UCR requires Chromatic dispersion compensation to be able to fully compensate a 150 km span but SUT supports only 135km / 35dB spans loss. The OTS must support pre- and post-dispersion compensation options but SUT only supports Pre-dispersion compensation.
4. SUT does not supports Four-to-one Muxponder.
5. SUT supports only SR, IR-1, LR-1, LR-2 for OC-48 interface, and SR, IR-2, LR-2 for OC-192 interface, SUT does not support 100G transponder, SUT supports only "1200km over SMF, 930km over NZDSF" for 10G and 450km over SMF, 930km over NZDSF for 40G".
6. SUT only supports OTU-2 and OTU-3 at client and network sides except 40G interface which supports OTU-3 only at network side.
7. The direction-less wavelength routing, color-less wavelength routing, and cascading of eight or more ROADMs are not supported by the SUT, and SUT as ROADM will need explicit configuration for it to pass-through all wavelengths those are not explicitly dropped or added, and Dynamic wavelength selection without pre-cabling, and adding or dropping all wavelengths from each of eight line-side fiber connections to tributary side optics are not supported by the SUT, and Wavelength hair-pinning capability and wavelength regeneration, including wavelength conversion, using back-to-back transponders or through-transponders via hair-pinning are not supported by the SUT, and optical multicasting capability is not supported by the SUT.
8. SUT only supports OTU-2 and OTU-3 at client and network sides except 40G interface which supports OTU-3 only at network side,
9. SUT supports mixed framed and unframed wavelength services via ALIEN wavelength only,
10. SUT GNE will not communicate with other Nodes in the absence of an OSC, SUT supports only 135km length and 35dB spans loss for OSC.
11. SUT only supports OTU-2 and OTU-3 at client and network sides except 40G interface which supports OTU-3 only at network side,
12. The SUT does not support selection of SONET or SDH per card or port level. However, SONET or SDH is set at system level, meaning either SUT is set for entirely SDH or set for entirely SONET, the SUT does not support 40G switching as SONET or SDH in TSF mode, however SUT does support 40G interface as SONET and SDH in OTS mode, the TSF must support SR, LR-1, LR-2, LR-3, and IR-1, IR-2, IR-3 for its SONET/SDH interfaces but SUT supports only SR, IR-1, LR-1, LR-2 for OC-48 interface, and SR, IR-2, LR-2 for OC-192 interface, and the TSF must support Intra-office (I-x) interface and Short-haul (S-n.x) interface for STM-1, STM-4, STM-16, STM-64 and STM-256, but SUT supports only VSR for STM-256, however all application codes supported for various values of n and x.
13. The TSF must support Link Capacity Adjustment Scheme (LCAS) for Virtual Concatenated signals but SUT does not support LCAS in SDH mode.
14. The TSF must support cross connects with Virtual Circuit (VC) VC-3/VC-4 granularity in SDH mode, but SUT only supports VC-4 granularity, and the TSF must support Virtual Concatenation (VCAT) as defined in ANSI T1.105-2001/ ITU-T G.707, but SUT only supports VCAT in VC-4 granularity.
15. 1:N and 4-Fibers Bidirectional Line Switched Ring (BLSR) are not supported by the SUT.
16. 1:1 is not supported by the SUT.
17. 4-Fibers BLSR is not supported by the SUT.
18. The SUT does not track PM data with 5-minute intervals and also does not track frame errors, P-Bit Parity Errors, C-Bit Parity Errors, FEBE, layer-1 statistics, layer-2 errors, and all QoS parameters defined for the RPR, however SUT supports Block Error PMs for SDH but only Bit-error PMs for SONET, and all PMs are collected in 15m intervals.
19. All statistics shall be tracked in five-minute intervals, with the ability reduce intervals for testing and analysis, but SUT does not track PM data with 5 min intervals, SUT does not support RPR.. The TSF EMS shall be able to track frame errors, P-Bit Parity Errors, C-Bit Parity Errors, and FEBE, but SUT does not support these errors tracking.
20. SUT does not support RPR.

Table 2-11. Other CRs and FRs (continued)

LEGEND:			
ANSI	American National Standards Institute	OLA	Optical Line Amplifier
BLSR	Bidirectional Line Switched Ring	OTN	Optical Transport Network
CR	Capabilities Requirement	OTS	Optical Transport System
dB	Decibel	OTU	Optical Transport Unit
DWDM	Dense Wavelength Division Multiplexing	PM	Power Management
EMS	Element Management System	QoS	Quality of Service
FEBE	Front End/Back End	RPR	Resilient Packet Rings
FR	Functional Requirement	ROADM	Reconfigurable Optical Add-Drop Multiplexor
G	Gigabit	SDH	Synchronous Digital Hierarchy
GNE	Gateway Network Element	SMF	System Management Facility
ID	Identification	SONET	Synchronous Optical Transport Network
IR	Intermediate Reach	SR	Short Reach
ITU-T	International Telecommunication Union - Telecommunication	STM	Synchronous Transport Module
		SUT	System Under Test
		TSF	Transport Switch Function
km	kilometer	UCR	Unified Capabilities Requirements
LCAS	Link Capacity Adjustment Scheme	VC	Virtual Circuit
LR	Long Reach	VCAT	Virtual Concatenation
NZDSF	Non-Zero Dispersion Shifted Fiber	VSR	Very Short Reach
OC	Optical Carrier		

12. TEST AND ANALYSIS REPORT. In accordance with the Program Manager's request, JITC did not prepare a detailed test report. JITC distributes interoperability information via the JITC Electronic Report Distribution system, which uses Non-secure Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System Tracking Program, which .mil/gov users can access on the NIPRNet at https://stp.fhu.disa.mil. Test reports, lessons learned, and related testing documents and references are on the JITC Joint Interoperability Tool at http://jit.fhu.disa.mil (NIPRNet). Information related to DSN testing is on the Telecommunications Switched Services Interoperability website at http://jitc.fhu.disa.mil/tssi.

(This page intentionally left blank.)

SYSTEM FUNCTIONAL AND CAPABILITY REQUIREMENTS

The Network Elements (NE) and Fixed Network Elements (F-NE) have required and conditional features and capabilities that are established by the Unified Capabilities Requirements (UCR). The System Under Test (SUT) does not need to meet conditional requirements. If they are provided, they must function according to the specified requirements. The detailed Functional requirements (FR) and Capability Requirements for NEs are listed in Table 3-1.

Table 3-1. NE Capability/Functional Requirements Table

ID	Requirement	UCR Ref (UCR 2008 CH 1)	F-NE
1	The introduction of an NE(s) shall not cause the E2E average MOS to fall below 4.0 as measured over any 5-minute time interval.	5.9.2.1 (1)	R
2	The introduction of an NE(s) shall not degrade the E2E measured BER to no more than .03 percent from the baseline minimum E2E digital BER requirement which is not more than one error in 1x109 bits (averaged over a 9-hour period).	5.9.2.1 (2)	R
3	The introduction of an NE(s) shall not degrade secure transmission for secure end devices as defined by UCR 2008, Section 5.2.2, DoD Secure Communications Devices.	5.9.2.1 (3)	R
4	The NE(s) shall support a minimum modem transmission speed of 9.6 kbps across the associated NE(s).	5.9.2.1 (4)	R
5	The NE(s) shall support a minimum facsimile transmission speed of 9.6 kbps across the associated NE(s).	5.9.2.1 (5)	R
6	The NE shall transport all call control signals transparently on an E2E basis.	5.9.2.1 (6)	R
7	[Conditional] The NEs that support a P2N capability shall meet the following additional requirements when deployed in a P2N architectural configuration:	5.9.2.1 (7)	C
7A	The aggregate egress from all NEs in the P2NP architecture must be identical to the aggregate ingress of all NEs in the same P2N architecture. However, if all or part of the P2N is operating in a P2MP mode that is applying multicast from a centrally designated NE to one or more of the associated peripheral NEs, the aggregate of the additional multicast traffic must be accounted for in the egress sum total.	5.9.2.1 (7A)	R
7B	Excluding latency, the P2N AP shall be measured as though it is a P2P architecture at the P2N AP NE endpoints ingress and egress points. As such, the P2N AP must meet all the other stated requirements of a P2P.	5.9.2.1 (7B)	R
7C	For a given P2N AP, the maximum latency allowed E2E, as measured over any 5-minute period at the P2N AP NE ingress and egress points, shall be 5 ms or less, when added in addition to the expected P2P latency. Hence, as an example, if the expected P2P latency requirement for a P2N AP is 50 ms, then P2N AP maximum latency, regardless of the number of NE hops between the ingress and egress NEs, the measured value shall not exceed 55 ms.	5.9.2.1 (7C)	R

Table 3-1. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH 1)	F-NE
8	The NE shall be able to propagate Carrier Group Alarms (CGAs) upon physical loss of the TDM interface. The NE shall provide the capability of detecting a carrier group alarm (CGA). When this alarm is detected, all associated outgoing trunks shall be made busy automatically to subsequent customer call attempts. Call attempts on associated incoming trunks shall not be processed. When possible, the Reverse Make Busy feature shall be exercised on incoming trunks. Voice switching systems using a TDM connection to an NE shall receive the proper CGAs from the NE upon loss of the transport link between NEs, regardless of whether the transport link is TDM, IP, or DLoS between the NEs. The NEs that support IP ingress or egress traffic either as inbound or outbound NE traffic and/or transport between NE(s) shall support one or more of the following routing protocols: Link-State and/or Distance-Vector, so the NE can notify the IP network (e.g., LAN, MAN), using one of these routing protocols, the condition of its link state for transporting ingress IP traffic, namely operational or down.	5.9.2.1.1	R
9	The NE shall assure that congestion between paired NEs does not affect DSN calls in progress or subsequent calls. Call congestion handling shall be met in one or more of the following ways.	5.9.2.1.2	R
9A	The NE shall implement TDM congestion control via one of the following methods: A. A dynamic load control signal (e.g., contact closure) shall be provided to the DSN switch per the following requirements: (1) The NE shall provide the capability to handle Carrier Group Alarm (CGA) indications from the carrier systems/equipment using the E-telemetry interface (scan points) for the TDM interfaces provided (e.g., DS0, DS1, and/or OC-X), and, comply to the Telcordia Technologies GR-303-CORE, System Generic Requirements, Objectives, and Interface, December 2000, Issue 4 and Telcordia Technologies TR-NWT-000057 that specifies the use of an COT generated DC contact closure alarm to indicate an “all-accessible-channels busy” condition.	5.9.2.1.2.1 (1A1)	C
9B	(2) The NE when interfaced to the network that provides an E-telemetry interface type (scan points) for alarm management shall be capable of CGA management that is used to minimize the effects of carrier failures on switching systems and on service. CGA scan point (binary condition, i.e., “closed” contact for active and “opened” for inactive states) when “closed” should busy out the failed circuits, release customers from the failed circuits, and prevent the failed circuits from seizing the DSN trunk equipment and prevent the NE from seizing the failed circuits.	5.9.2.1.2.1 (1A2)	C
9C	(3) The DSN CGA System Operation can be divided into three parts, i.e., detection of the carrier failure, conditioning the failed trunk, and reaction of the switching equipment to the processing of the failure. Requirements for scan point CGA are: (a) Sense Point Interface: The switching system shall provide sense points to which external CGAs can be interfaced to, so that failure of the carrier equipment shall cause the trunks to be removed from service. (b) Call Processing Actions: Receipt of a CGA shall cause call processing to be aborted on associated trunks that are not in the talking state. (c) Trunk Conditioning: Receipt of a CGA shall cause the following actions on the affected trunks: (i) Idle trunks shall be removed from the idle list. Subsequent calls for service must be ignored for the duration of the CGA. Busy-back shall be returned on those incoming trunks, which are optioned for busy-back while in the out-of-service state and proper MLPP treatment shall be applied. (ii) Trunks in the talking state shall be monitored for disconnect, after which they are to be placed in the same state as described above for idle trunks.	5.9.2.1.2.1 (1A3)	C
9D	(4) Restoration of Service: All trunks affected shall be returned to their previous state after the CGA is removed. B. Congestion is not possible in the NE by nature of its functioning (e.g., a TDM multiplexer or transcoder). C. A software capability in limiting the provisioning of the ingress and egress interfaces making congestion impossible even under the worst congestion scenario. This can be done by limiting the bearer or aggregate provisioning.	5.9.2.1.2.1 (1A4, 1B, 1C)	C

Table 3-1. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH 1)	F-NE
10	2. The addition of NEs with TDM transports shall not increase the one-way latency per NE pair when measured from end to end over any 5-minute period specified as follows: a. Time Division Multiplexing ingress G.711 (non-secure calls) to non-transcoding G.711 TDM egress shall not increase delay more than 10 ms per NE pair as measured end-to-end. b. Time Division Multiplexing ingress G.711 (non-secure calls) to transcoding TDM egress with compression codecs (Section 5.9.2.2, Compression) shall not increase delay by more than 100 ms per NE pair as measured end-to-end. c. Time Division Multiplexing ingress G.711 (secure calls) to non-transcoding TDM egress G.711 shall not increase delay by more than 50 ms per NE pair as measured end-to-end. d. Time Division Multiplexing ingress G.711 (secure calls) to transcoding TDM egress with compression codecs (Section 5.9.2.2, Compression) shall not increase delay by more than 250 ms per NE pair as measured end-to-end.	5.9.2.1.2.1 (2A, 2B, 2C, 2D)	C
11	The NE(s) using IP transport shall implement IP congestion control. Congestion may be controlled by using DiffServ, which shall be capable of providing preferential treatment for call congestion over other media types IAW Section 5.3.3, Network Infrastructure End-to-End Performance Requirements, and a capability to limit the provisioning of input and output interfaces so congestion is impossible under the worst transport congestion scenario. The IP interface parameters subject to ingress or egress requirements shall be met IAW Section 5.9.2.3.9, IP Interface.	5.9.2.1.2.2	C
12	The NE shall implement DLoS congestion control based on the DSN traffic and signaling type to be transported. (Please see Following)	5.9.2.1.2.3	C
13	The NE transporting only TDM bearer and signaling traffic shall implement DLoS congestion control via one or more of the following methods: a. A dynamic load control signal (e.g., contact closure). b. Congestion is not possible in the NE so the maximum ingress throughput into the NE is configured so it does not exceed the DLoS link maximum egress transport capability to include all DLoS overhead control traffic between the transport devices. c. A software capability in limiting the provisioning of the ingress and egress interfaces making congestion impossible even under the worst congestion scenario. This can be done by limiting the bearer or aggregate provisioning.	5.9.2.1.2.3 (1A, 1B, 1C)	C
14	The NE transporting only ingress IP traffic, and using a DLoS transport, excluding 802.11, and/or 802.16 series standards, -shall implement DLoS IP congestion control per Section 5.9.2.1.2.2, For IP Transport. Additionally, IP congestion control may include a standards-based or proprietary protocol between the NEs that will adjust the QoS of the NE based on DLoS transport monitoring feedback to the NE to accommodate for changing environmental link conditions.	5.9.2.1.2.3 (2)	C
15	The NE transporting both TDM and IP ingress traffic simultaneously over the same DLoS transport link shall meet the following requirements: a. [Required] The NE shall provide congestion control so it provides the same level of capability, respectively, for the appropriate traffic type, TDM and IP, per the requirements for single traffic type ingress or egress to the NE. Additionally, the congestion control may include a standards-based or proprietary protocol between the NEs that will adjust the QoS of the NE based on DLoS transport monitoring feedback to the NE to accommodate for changing environmental link conditions. b. [Conditional] The use of DLoS transport shall not increase the one-way latency or packet delay per the requirements for TDM ingress and TDM or IP egress interfaces per the appropriate Section 5.9.2.1.2.1, For TDM Transport, and Section 5.9.2.3.9, IP Interface, respectively.	5.9.2.1.2.3 (3A, 3B)	C
16	The NE used for voice compression shall support at least one of the following standards: • ITU-T Recommendation G.726 • ITU-T Recommendation G.728 • ITU-T Recommendation G.729	5.9.2.2	C
17	If provided, the NE shall provide for a 2-wire and/or 4-wire analog trunk circuit(s) interface that interfaces using industry standard signaling and facility arrangements per one or more of the following:	5.9.2.3.1	C
18A	1. E&M Trunk Circuits: The NE shall interface with exchange carriers using industry standard E&M signaling. The switching system shall interface with Type I and Type II	5.9.2.3.1 (1)	C

Table 3-1. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH 1)	F-NE
	E&M signaling in accordance with paragraph 9 and subparagraphs of GR-506-CORE. The switching system shall interface with Type V E&M signaling as defined in Paragraphs 6.8.5, 6.8.6, 6.8.7.2, 6.8.8.2, and 6.8.8.3 of Telcordia Technologies Document SR-2275. The DSN switch analog trunk interface shall always originate on the M-lead.		
18B	2. Single Frequency Trunk Circuits: The NE will interface with external switching facility (SF) equipment using a 4-wire E&M trunk circuit, either Type I or II. The DSN in-band signaling equipment utilizing SF will place a 2600 Hz tone on the circuit to indicate the idle state (on-hook) and the tone will be removed from the circuit to indicate the busy state (off-hook). Signaling states will be conveyed via E and M leads (Type I or II) to the telephone equipment terminating the circuit on the equipment side of the interface. The SF trunk interface consists of only the voice path conductors (T, R, T1, R1), but at a point between this transmission facility interface and the switching function the SF signal will be translated back to the two-state dc signals.	5.9.2.3.1 (2)	C
18C	3. Dual Frequency Trunk Circuits: The Dual Frequency Signaling Unit (DFSU) equipment used in the DSN operates in much the same way as an SF unit, except that whenever the 2600 Hz tone is removed from the circuit a 2800 Hz tone is applied for a short period (175 ms maximum). The 2800 Hz tone burst will serve as a confirmation tone; the receiving signaling unit will only transition from on-hook to off-hook if the loss of the 2600 Hz tone is followed by the 2800 Hz tone. This prevents false on-hook to off-hook transitions from occurring due to a break in the communications circuit. Like the SF trunk interface, the DF trunk interface will consist of only the voice path conductors (T, R, T1, R1). The NE shall interface an external DFSU using a 4-wire E&M trunk circuit with Type I or II E&M signaling. This connection is on the equipment-side of a DF trunk interface.	5.9.2.3.1 (3)	C
19	The NE used for serial interface connections shall be in accordance with one of the following standards: • ITU-T Recommendation V.35 • TIA-232-F • EIA-449-1 • TIA-530-A	5.9.2.3.2	C
20	The ISDN BRI interface shall meet the requirements and conditions IAW Section 5.3.2.31.2, National ISDN 1/2 Basic Access.	5.9.2.3.3	C
21	If provided, the NE shall meet the following DS1 (T1) interface requirements and conditions of a PCM-24 Digital Trunk Interface. PCM-24 Digital Trunk Interface: An NE shall provide a PCM-24 channel digital interface with a 1.544 Mbps T1 bit stream configured in either the D3/D4 (Superframe) framing format or the D5 Extended Superframe (ESF) framing format. D5 is also referred to as Extended Frame (EF). The same framing format shall be used in both directions of transmission. Voice signals shall be encoded in the 8-bit μ (255 quantized values) pulse code modulation (PCM) encoding law. Supervisory and dial pulse (DP) signals shall utilize the A and B bits of the D3/D4 format or the A, B, C, and D bits of the D5 format for pre-CCS7 configurations. Voice channel address in-band signaling shall be provided on individual channels. The D5 format shall be the preferred and system "goal" digital framing format and shall be provided in accordance with MIL-STD-187-700. 1. Interface Characteristics: The NE shall use the DS1 24 channel standard interface as specified in ANSI T1.102, "Digital Hierarchy – Electrical Interfaces." Table 5.9.2.3.4-1, PCM-24 Electrical Interface Characteristics, provides the electrical characteristics at the interface. Table 5.9.2.3.4-2 and Table 5.9.2.3.4-3 provide a listing of the framing characteristics. (Please see UCR 2008, Change 1-Pages 1898 thru 1900)	5.9.2.3.4	C
22A	2. Supervisory Channel Associated Signaling: On-hook and off-hook status of each channel is transmitted and derived from the coding of the "A" and "B" signaling bits. Trunk seizure, answer supervision, dial pulse digits (DPs), preemption signals, and all other trunk supervisory information shall be sent and received on a per-channel basis using this scheme. Per-trunk signaling in the DSN switching system shall control the value of the "A" and "B" bits to indicate an on-hook ("A" = 0, "B" = 0) or an off-hook ("A" = 1, "B" = 1) condition. When receiving supervisory status on digital trunks using the PCM-24 format, the DSN switching system shall interpret the combination of the "A" bit = 0 andthe "B" bit = 0 as on-hook, and the combination bit = 1 and "B" bit = 1 as an off-hook indication. When signaling on Voice Frequency (VF) channels using the PCM-24 format, the least significant bit of each channel, every six frames, shall	5.9.2.3.4 (2)	C

Table 3-1. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH 1)	F-NE
	carry signaling information. Utilizing the four-state signaling option of the Superframe (D3) format, frame 6 shall contain the "A" channel signaling information and frame 12 shall contain the "B" channel signaling information. The switching system shall also interpret the combination of "A" bit = 1, "B" bit = 0, with bit position 2 in all 24 channels in the Superframe (D3) format equal to "0" as a channel alarm indication and shall also interpret the combination of "A" bit = 1, "B" bit = 0 as a remote make busy. In the ESF format ANSI defines a sixteen-state signaling option that labels the signaling bits "A" (frame 6), "B" (frame 12), "C" (frame 18), and "D" (frame 24). Because DSN does not require the "C" and "D" signaling channels the four-state option shall be used to allow changes in "A" and "B" signaling states to be transmitted twice as often. Utilizing Frames 6 and 18 in the 24-frame Extended Superframe shall contain the "A" channel signaling information; frames 12 and 24 shall contain the "B" channel signaling information.		
22B	3. Clear Channel Capability: The NE shall be capable of transmitting and receiving B8ZS line coding in accordance with MIL-STD-187-700.	5.9.2.3.4 (3)	C
22C	4. Alarm and Restoral Requirements: The NE shall provide the alarm and restoral features on the digital interface unit (DIU) as defined in Table 5.9.2.3.4-4, PCM-24 Alarm and Restoral Requirements. (Please see UCR 2008, Change 1-Page 1901)	5.9.2.3.4 (4)	C
23	If provided, the NE shall meet the following E1 interface requirements and conditions of a PCM-30 Digital Trunk Interface: PCM-30 Digital Trunk Interface: The NE shall provide PCM-30 digital interfaces at a data rate of 2.048 Mbps. The PCM-30 interfaces shall meet the requirements of ITU-T Recommendation G.703 and ITU-T Recommendation G.732. Voice signals in the PCM-30 framing format shall utilize the A-law encoding technique in accordance with ITU-T Recommendation G.772 (REV), "Protected Monitoring Points on Digital Transmission Systems." The pertinent requirements for the PCM-30 interface are summarized in Table 5.9.2.3.5-1, PCM-30 Electrical Interface Characteristics. (Please see UCR 2008, Change 1-Page 1902)	5.9.2.3.5	C
23A	1. Supervisory Channel Associated Signaling: When receiving supervisory status on digital trunks using the PCM-30 format, the DSN switching system shall interpret the combination of the "A" signaling channel bit = 1 and the "B" signaling channel bit = 1 as on-hook, and shall interpret the combination of the "A" signaling channel bit = 0 and the "B" signaling channel bit = 1 as an off-hook indication. The DSN switching system shall also interpret the combination of "A" bit = 1 and "B" bit = 0 as a channel alarm indication and a remote make busy. Bits "C" and "D" are not used in the DSN for signaling or control and therefore shall be set to the values "C" = 0 and "D" =1 in accordance with ITU-T Recommendation G.704.	5.9.2.3.5 (1)	C
23B	2. Alarm and Restoral Requirements: The NE shall provide the alarm and restoral features on the DIU in order to be compatible with PCM-30 facilities and terminal equipment, as shown in Table 5.9.2.3.5-3, PCM-30 Alarm and Restoral Requirements. (Please see UCR 2008, Change 1-Page 1903)	5.9.2.3.5 (2)	C
24	The DS3 interface shall meet the following requirements and conditions. Frame structure shall include M13 framing in accordance with ANSI T1.107-2002.	5.9.2.3.6.1 (1)	R
25	Frame structure may include C-bit parity application in accordance with ANSI T1.107-2002.	5.9.2.3.6.1 (2)	C
26	The line coding shall be bipolar 3 zero substitution (B3ZS) in accordance with ANSI T1.102-1993.	5.9.1.5.3.6.2	R
27	The NE shall be able to derive a timing signal from an internal source, an incoming digital signal, or an external source IAW Section 5.3.2.12.14.1.1, Timing Modes (5.3.2.12.14.1.1 Timing Modes): [Required: Media Gateway (MG)] The MGs shall meet the external timing mode requirements specified in the Telcordia Technologies GR-518-CORE, Paragraph 18.1. Most SMEOs and PBX1s will only support line timing 5.3.2.12.14.1.1.1 External Timing Mode - [Required: MG] The MGs shall support external timing modes as defined in Telcordia Technologies TR-NWT-001244. 5.3.2.12.14.1.1.2 Line Timing Mode - [Required: MG] The MGs shall support line timing modes as defined in Telcordia Technologies TR-NW-001244. 5.3.2.12.14.1.2 Internal Clock Requirements 5.3.2.12.14.1.2.1 General - [Required: MG] The MGs shall provide internal clock	5.9.2.3.7	R

Table 3-1. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH 1)	F-NE
	requirements as described in the Telcordia Technologies GR-518-CORE, Paragraph 18.2. 5.3.2.12.14.1.1.2.2 Stratum 4 Clock - [Required: MG] The MGs shall provide a stratum 4 or better internal clock. 5.3.2.12.14.1.2 Synchronization Performance Monitoring Criteria - [Required: MG] The MGs shall meet the synchronization performance monitoring criteria as described in Telcordia Technologies GR-518-CORE, Paragraph 18.3		
28	The OC-X interface shall be IAW Section 5.5.3.2, Optical Transport System Interface, and/or appropriate SONET commercial standards. (NOTE: X stands for the capacity (e.g., 3, 48, 192 and higher)	5.9.2.3.8	C
29	The NE having an IP interface and using DLoS transport comprised of 802.11 and/or 802.16 series standards shall instead meet the requirements for a WAB contained in Section 5.3.1.7.2, Wireless. All other IP configurations shall meet the following:	5.9.2.3.9	C
29A	a. Delay. The addition of NEs with IP transports shall not increase the one-way latency per NE pair when measured from end to end over any 5-minute period specified as follows: (1) Time Division Multiplexing ingress G.711 (non-secure calls) to non-transcoding G.711 IP egress shall not increase delay more than 50 ms per NE pair as measured end-to-end. (2) Time Division Multiplexing ingress G.711 (non-secure calls) to transcoding IP egress with compression codecs (Section 5.9.2.2, Compression) shall not increase delay by more than 100 ms per NE pair as measured end-to-end. (3) Time Division Multiplexing ingress G.711 (secure calls) to non-transcoding G.711 IP egress shall not increase delay by more than 50 ms per NE pair as measured end-to-end. (4) Time Division Multiplexing ingress G.711 (secure calls) to transcoding IP egress with compression codecs (Section 5.9.2.2, Compression) shall not increase delay by more than 250 ms per NE pair as measured end-to-end.	5.9.2.3.9	C
29B	b. Jitter. The addition of an NE shall not cause jitter measured from ingress to egress to increase by more than 5 ms averaged over any 5-minute period.	5.9.2.3.9	C
29C	c. Packet Loss. The addition of an NE shall not cause packet loss measured from ingress to egress to increase by more than 0.05 percent averaged over any 5-minute period.	5.9.2.3.9	C
29D	d. [Required: F-NE, D-NE] For VVoIP systems, if the system decrypts the VVoIP traffic and applies a proprietary encryption approach before transmittal between the two components of the single vendor system, then the system proprietary encryption approach shall be one of the encryption and integrity-approved approaches defined in Section 5.4, Information Assurance Requirements NOTE: For example, if the NE decrypts the AS-SIP with TLS packets between the NEs and re-encrypts it using NE proprietary encryption methods, then the proprietary method must be one of the cryptographic methods defined in Section 5.4, Information Assurance Requirements, (e.g., IPSec with AES-128 bit encryption, HMAC-SHA1 for integrity, and DoD PKI for authentication). All Section 5.4, Information Assurance Requirements, approved encryption and integrity approaches use FIPS PUB 140-2 cryptographic modules (or have been granted a formal waiver by National Institute of Standards and Technology (NIST)). Importantly, proprietary only refers to the lack of interoperability with a different vendor's NE and all cryptographic approaches used in Section 5.4, Information Assurance Requirements, are standards based.	5.9.2.3.9	R
29E	e. [Required: F-NE, D-NE] The VVoIP systems that use proprietary encryption approaches within the system shall restore the VVoIP packets to their original format (e.g., AS-SIP with TLS and SRTP) upon exiting from the system to ensure the VVoIP session can complete successfully.	5.9.2.3.9	R
29F	2. [Conditional] The IP interface shall meet the IP requirements detailed in the DISR and Section 5.3, IP-Based Capabilities and Features, inclusive.	5.9.2.3.9	C
30	The NE devices are to be managed by at least one of the following: A front or back panel and/or external console control capability shall be provided for local management. Remote monitoring and management by the Advanced DSN Integrated Management Support System (ADIMSS) or similar Network Management (NM) systems developed by DoD Components. The following requirements apply:	5.9.2.4.1	R

Table 3-1. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH 1)	F-NE
	(1) [Required: Data Interface] The NE shall provide network management (NM) data/monitoring via one or more of the following physical interfaces: ** Ethernet/TCP/IP (IEEE 802.3) ** Serial (RS-232)/Asynchronous ** Serial/Synchronous (X.25 and/or BX.25 variant) All data that is collected shall be accessible through these interfaces. For NM purposes, the NE must provide no less than two separate data channels. They may be physically separate (e.g., two distinct physical interface points) or logically separate (e.g., two user sessions through a single Ethernet interface). The data may be sent in ASCII, binary, or hexadecimal data or ASCII text designed for screen/printer display. The data channels shall be used for and, as such, must be capable of providing: ** Alarm/Log Data ** Performance Data (e.g., traffic data) ** NE access (to perform NE data fill administration and network controls) (2) [Required: Fault Management] The DSN telephone switching systems shall detect fault (alarm) conditions and generate alarm notifications. The alarm messages must be sent to the assigned NM Alarm channel in near-real time. No alarm restriction/filtering is necessary. In addition to the data formats in Section 5.3.2.17, Management of Network Appliances, alarms may be sent as Simple Network Management Protocol (SNMP) traps. If this channel is also used to output switch administrative log information, the alarm messages must be distinguishable from an administrative log message (3) [Required: Configuration Management] Requirements for this feature shall be in accordance with Telcordia Technologies GR-472-CORE, Section 4.		
31	The NE shall report any failure of self-test diagnostic function on non-active and active channels on a noninterference basis to the assigned NMS.	5.9.2.4.2	C
32	The NE shall provide loopback capability on each of the trunk-side interfaces IAW ITU-T Recommendation V.54.	5.9.2.4.3	C
33	Loss of power should not remove configuration settings. Unit should be restored to the last customer-configured state before the power loss, without intervention when power is restored.	5.9.2.4.4	R
34	The NEs using DLoS transport shall support the following: a. A minimum MOS score as defined in Section 5.9.2.1, General Requirements, performance requirement or better as measured in any 5-minute interval using ITU-T Recommendation P.862 testing standard. b. [Required] The minimum acceptable maximum transmission range (MTR) shall be 300 feet based on operating in an open air-minimal obstruction, clear line-of-sight environment with the DLoS transport device operating at or near full power mode. Based on the testing results, the estimated maximum performance range while still maintaining MOS requirements, as required in item a, shall hereby be referred to as the NE DLoS transport MTR. The MTR baseline-testing environment shall be while operating in an open air-minimal obstruction, clear line-of-sight environment with the DLoS transport device operating at or near full power mode. The NE shall be tested at a minimum operating height of 25 feet with a clear unobstructed line of sight between NEs at a minimum range of 150 feet. The NEs may be tested with attenuation inserted to simulate the actual NE DLoS transport capability from which the maximum MOS performance range MTR can be extrapolated. The value determined shall be included in the APL report. Refer to Section 5.9.2.5.3, Submission of DLoS Transport NEs to UCCO for DSN Connection Request, concerning guidelines on submitting the DLoS transport NE engineering analysis package.	5.9.2.4.5	R
35	The DLoS transport NEs shall be engineered properly so that the DLoS transport transmitting or receiving devices achieve the required performance requirements in their specific deployed environment. The user shall submit a network design and engineering performance analysis with supporting calculations to meet minimum MOS performance with the request for DSN connection. Included is the calculation and data required for determining the MDR, as defined in Section 5.9.2.5.1, DLoS Transport NE Maximum Deployment Range. For certification procedures, the UCCO submittal shall also include wireless security compliancy as identified in Section 5.9.2.6, Security.	5.9.2.5.3	C

Table 3-1. NE Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH 1)	F-NE
36	All components of the NE shall meet security requirements, for each supported mode, as outlined in DoDI 8510.01 and the applicable STIG(s).	5.9.2.6	R
37	1. If a DoD-approved WIDS exists for the DLoS transport technology used, the NE DLoS transport link(s) shall be monitored in according with the appropriate STIG(s).	5.9.2.7	C

LEGEND:

ANSI	American National Standards Institute	ISDN	Integrated Services Data Network
AP	Association Path	ITU	International Telecommunications Union
APL	Approved Product List	ITU-T	ITU Telecommunications Union - Telecommunications Sector
ASLAN	Assured Services LAN		
AS-SIP	Assured Services Session Initiation Protocol	Kbps	Kilobits per second
		LAN	Local Area Network
B8ZS	Bipolar with Eight-Zero Substitution	MAN	Metropolitan Area Networks
BER	Bit Error Rate	MLPP	Multi-Level Precedence and Preemption
BRI	Basic rate Interface	MOS	Mean Opinion Score
C	Conditional	Ms	Millisecond
CE	Customer Edge	NMS	Network Management System
CGA	Carrier Group Alarm	NSA	National Security Agency
CH	Change	P2N	Point-to-Network
COT	Continuity Testing	P2NP	Point-to-Network-Point
D-NE	Deployed-Network Element	P2MP	Point-to Multipoint
DAA	Designated Approving Authority	P2P	Point-to-Point
DF	Default	PCM	Pulse Code Modulation
DISR	DoD Information technology Standards and Profile Registry	PKI	Public Key Infrastructure
		PRI	Primary rate Interface
DLoS	Direct Line of Sight	QoS	Quality of Service
DoD	Department of Defense	R	Required
DoDI	DoD Instruction	Ref	Reference
DS	Digital Signal	SCIP	Secure Communication Interoperability Protocol
DSN	Defense Switched Network	SONET	Synchronous Optical Network
DVX	Deployed Voice Exchange	SRTP	Secure Real-Time Protocol
E1	European 1 (2048 bps, 30-channel PCM)	STIG	Security Technical implementation Guide
E2E	End to End	T1	Trunk 1 (1544 bps, 24-channel PCM)
F-NE	Fixed-Network Element	TCP	Transmission Control Protocol
FIPS	Federal Information Processing Standard	TDM	Time Division Multiplexing
Hz	Hertz	TIA	Telecommunications Industry Association
HMAC-SHA1	Secure cryptographic hash algorithm published by the United States Government	TLS	Transport Layer Security
		UCCO	Unified Capabilities Certification Office
		UCR	Unified Capabilities Requirements
IAW	In Accordance With	VVoIP	Voice and Video over Internet Protocol
IP	Internet Protocol	WIDS	Wireless Intrusion Detection System
IPSec	Internet Protocol Security		

OPTICAL TRANSPORT SYSTEM (OTS) and TRANSPORT SWITCH FUNCTION (TSF) FUNCTIONAL AND CAPABILITY REQUIREMENTS

The OTS and TSF products have required and conditional features and capabilities that are established by the Unified Capabilities Requirements (UCR). The System Under Test (SUT) need not provide conditional requirements. If they are provided, they must function according to the specified requirements. The detailed Functional Requirements (FR) and Capability Requirements (CR) for OTS and TSF are listed in Table 3-2. Detailed Information Assurance (IA) requirements are included in Reference (e) and are not listed below.

Table 3-2. OTS and TSF Capability/Functional Requirements Table

ID	Requirement	UCR Ref (UCR 2008 CH 1)	R/C
	5.5.3.2.2.1 Overall Requirements		
1	The OTS family of equipment shall be currently available, commercial-off-the-shelf (COTS) equipment.	5.5.3.2.2.1 (1)	R
2	The OTS shall support a minimum of 80 ITU-T G.694.1 grid wavelengths per line-side optical fiber.	5.5.3.2.2.1 (2)	R
3	The OTS shall support a minimum of 160 ITU-T G.694.1 grid wavelengths per line-side optical fiber	5.5.3.2.2.1 (3)	C
4	The OTS shall support mixed bit rate signals: 2.5 Gbps, 10 Gbps, and 40 Gbps.	5.5.3.2.2.1 (4)	R
5	The OTS shall support mixed bit rate signals: 2.5 Gbps, 10 Gbps, 40 Gbps, and 100 Gbps.	5.5.3.2.2.1 (5)	C
6	The OTS shall utilize the ITU-T specified Optical Supervisory Channel (OSC) for in-band management communication.	5.5.3.2.2.1 (6)	R
7	The OTS shall support all specified wavelengths for all specified bit rate and signal format.	5.5.3.2.2.1 (7)	R
8	The OTS shall support at least SSMF (ITU-T G.652), Enhanced Large Effective Area Fiber, TW-RS, and TW-C (ITU-T G.655).	5.5.3.2.2.1 (8)	R
9	The OTS shall support the ability of 80, 40G wavelengths to traverse a minimum of five ROADM using fibers specified above for a minimum reach of 1,500 km without regeneration (O-E-O conversion) at BER less than 1x 10-15.	5.5.3.2.2.1 (9)	R
10	The OTS shall support the ability of 80, 40G wavelengths to traverse a minimum of five ROADM using fibers specified above for a minimum reach of 1,500 km without regeneration (O-E-O conversion) at BER less than 1x 10^{-15}.	5.5.3.2.2.1 (10)	R
11	The OTS shall support the ability of 80, 100G wavelengths to traverse a minimum of five ROADM using fibers specified above for a minimum reach of 1,200 km without regeneration (O-E-O conversion) at BER less than 1x 10-15.	5.5.3.2.2.1 (11)	R
12	The OTS shall support span length up to 150 km and span loss up to 50 dB. The reach shall not be limited by optical supervisory channel performance.	5.5.3.2.2.1 (12)	R
13	The OTS shall allow the remote configuration of wavelengths added or dropped from the system.	5.5.3.2.2.1 (13)	R
14	Client interfaces available on the OTS shall meet the generally accepted standards or specifications for the interface (e.g., OC-192) Telcordia Technologies GR-253 standards, Synchronous Transport Module (STM)-16 and STM-64 International Telecommunications Union (ITU)-T G.707 standards, and Gigabit Ethernet (GE) and 10 GE IEEE 802.3 standards).	5.5.3.2.2.1 (14)	R
15	The OTS shall support remote shelf location with up to 6 dB optical power budget between terminal and remote locations.	5.5.3.2.2.1 (15)	R
16	The OTS shall support universal (or single part code) MUX/DEMUX circuit-packs at all Terminals and ROADM nodes.	5.5.3.2.2.1 (16)	R
17	The OTS shall enable pre- and post- dispersion compensation options.	5.5.3.2.2.1 (17)	R
18	The OTS T&S requirements are defined in Section 5.5.4.2.3, General DISN NE Requirements, and Section 5.5.4.2.4, Optical Transport System.	5.5.3.2.2.1 (18)	
	Performance Requirements	**5.5.3.2.2.2**	
19	Jitter tolerance shall comply with Telcordia Technologies GR-253 Type II and ITU-T G.958.	5.5.3.2.2.2 (1)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
20	Jitter transfer shall comply with Telcordia Technologies GR-253 and ITU-T G.958.	5.5.3.2.2.2 (2)	R
21	In a single vendor environment, a wavelength shall traverse up to at least 20 transponders before termination of the signals is required at a terminal site. This shall be true for all data rates specified.	5.5.3.2.2.2 (3)	R
22	The OTS shall tolerate a persistent input channel signal timing deviation of at least +/- 20 parts per million (ppm). This implies that the OTS must (1) operate properly in normal condition (i.e., without alarms) when any or all tributaries have long-term frequency offsets of up to +/- 20 ppm, and (2) maintain the system performance objectives for concatenated OTS systems.	5.5.3.2.2.2 (4)	R
23	When a signal passes through concatenated OTS sections, the output jitter shall not exceed the network interface limits of ITU-T Recommendation G.825.	5.5.3.2.2.2 (5)	R
24	When one or more channel (up to 90 percent) fails or is removed (either instantaneously or sequentially), the remaining channels shall not experience increasing bit errors or loss of operating margin. In addition, when failed channels are restored or new channels are added, the existing channels shall not experience any transient or long-term performance deterioration.	5.5.3.2.2.2 (6)	R
25	The maximum uncompensated PMD the system can tolerate at 40/100 Gbps shall not exceed that tolerated at 10 Gbps.	5.5.3.2.2.2 (7)	R
	Reliability and Quality Assurance	**5.5.3.2.2.2.1**	
26	The OTS equipment shall meet the following quality program requirements, unless specifically overridden or modified by another requirement in this document: • Telcordia Technologies GR-282-CORE • Telcordia Technologies GR-2911-CORE • Telcordia Technologies TR-NWT-000179 • Telcordia Technologies TR-NWT-000418 • Telcordia Technologies SR-NWT-002419	5.5.3.2.2.2.1 (1)	R
27	A list shall be available of country of origin of the critical components as well as final assembly location of the system.	5.5.3.2.2.2.1 (2)	R
28	Each OTS element shall meet requirements addressed in this document and shall have met European Community (EC) or Pacific Host Nation approvals required for foreign countries. Provide information on the countries that currently approve the equipment, including equipment part numbers and other applicable documentation.	5.5.3.2.2.3 (1)	R
29	The vendor shall have a program underway to obtain approvals and permits for connection and operation of the equipment to the public networks in the EC and Pacific areas. A list of counties where such approval has been obtained or where it is actively working toward approval. (Note: this list will change with time.)	5.5.3.2.2.3 (2)	R
30	Each NE shall meet requirements addressed in this section and shall be compliant, at a minimum, without future hardware and/or memory upgrades or replacements.	5.5.3.2.2.3 (3)	R
31	Equipment racks' weight shall be within acceptable standards defined for raised floor application.	5.5.3.2.2.3 (4)	R
32	Equipment racks shall allow cable installation above and below each rack.	5.5.3.2.2.3 (5)	R
33	Each OTS element shall be able to receive all types of cables from the top or bottom of the bay or cabinets. When receiving from the bottom, it shall be able to accommodate a raised floor environment.	5.5.3.2.2.3 (6)	R
34	All interbay cabling shall be routed above and below each rack allowing various different cable lengths up to 100 meters. If the equipment cannot support 100 meters, the vendor shall state the maximum cable length supported.	5.5.3.2.2.3 (7)	R
35	Within a OTS element, all intrasystem cabling shall maximize separation of redundant cables and fibers (i.e., working/protection, east/west, timing cables, switch cables).	5.5.3.2.2.3 (8)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
36	All working signal cables shall be routed on separate physical paths from the protection cables within the system. Between systems, all separations shall be maintained. All intersystem connections shall be able to support a minimum distance of 100 meters.	5.5.3.2.2.3 (9)	R
37	A and B power cables shall have physically diverse routing within the bay or cabinet.	5.5.3.2.2.3 (10)	R
38	Current drain information shall be provided to outline current draws in both normal and worst case voltage scenarios. (The latter information shall also address impacts of failed feeds and temperature where variable speed fans or other factors make such considerations appropriate. When multiple configurations are possible because of card variety, test data on several "generic" configurations shall be provided with a table of power numbers to help the user interpolate the approximate values of other configurations.	5.5.3.2.2.3 (11)	R
39	Each OTS element, shelf, or circuit pack, whichever is the smallest independent load device of the OTS element shall obtain power from two completely independent power units. Furthermore, the return path from the power units shall remain completely independent (Telcordia TechnologiesTR-NWT-000295). If one of the power units fails, an alarm shall be generated and the load shall be carried by the other unit without manual intervention and without interruption of service or functionality. The other power unit shall support the operation of the element, shelf, or circuit pack until the problem with the faulty unit is corrected.	5.5.3.2.2.3 (12)	R
40	All OTS elements shall conform to the spatial and environmental criteria specified in Telcordia Technologies FR 796 and GR-63-CORE.	5.5.3.2.2.3 (13)	R
41	All OTS elements, along with its power distribution panel and all associated or ancillary hardware, shall be capable of being mounted in a standard EIA 310C 23-inch relay rack, 84-inch in height.	5.5.3.2.2.3 (14)	R
42	All OTS elements shall be capable of being operated and maintained with access only to the front of the unit.	5.5.3.2.2.3 (15)	R
43	All OTS elements shall be capable of being mounted in a back-to-back arrangement or directly against a building wall.	5.5.3.2.2.2.3 (16)	R
44	All OTS elements, along with their power distribution panel and all associated or ancillary hardware, shall be capable of being mounted in a standard EIA 310C 23-inch relay rack, 78 inches in height.	5.5.3.2.2.2.3 (17)	R
45	All OTS elements, along with their power distribution panel and all associated or ancillary hardware, shall be capable of being mounted in standard EIA 19-inch relay rack, 78 inches in height.	5.5.3.2.2.2.3 (18)	R
46	All OTS elements, along with their power distribution panel and all associated or ancillary hardware, shall be capable of being mounted in X-Mark/CDT cabinets, part number XSL78-4-1S0002, size 78 inches x 23 inches x 30 inches.	5.5.3.2.2.2.3 (19)	R
47	All OTS elements shall demonstrate an operational availability of all functions and services of 99.9997 percent.	5.5.3.2.2.2.3 (20)	R
48	All OTS elements shall comply with the earthquake, office vibration, and transportation vibration criteria specified in Telcordia Technologies GR-63-CORE, Section 4.4, Earthquake, Office Vibration, and Transportation Vibration.	5.5.3.2.2.2.3 (21)	R
49	All OTS elements shall be fully Network Equipment-Building System (NEBS), Level 3 compliant.	5.5.3.2.2.2.3 (22)	R
50	All OTS elements shall meet the environmental conditions described in Telcordia Technologies GR-63-CORE.	5.5.3.2.2.2.3 (23)	R
51	All OTS elements shall meet the environmental conditions described in European Telecommunications Standards Institute (ETSI) ETSI 300 019.	5.5.3.2.2.2.3 (24)	R
52	All OTS elements shall be designed to operate in a communication equipment environment, adjacent to or in the vicinity of others types of equipment that may include digital radio equipment, fiber optic terminal equipment, frequency-division multiplexing (FDM) analog microwave, very high frequency (VHF)/ultra high frequency (UHF) base stations, satellite ground terminals, transfer trip and power line carrier equipment, and telephone signaling equipment.	5.5.3.2.2.2.3 (25)	R
53	All OTS elements shall meet the Electromagnetic Compatibility (EMC)/electromagnetic interference (EMI) requirements defined in Telcordia Technologies GR-1089-CORE.	5.5.3.2.2.2.3 (26)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
54	All OTS elements shall meet the EMC/EMI requirements defined in Federal Communications Commission (FCC) Part 15 Class A.	5.5.3.2.2.2.3 (27)	R
55	All OTS elements shall meet the EMC/EMI requirements defined in ETSI EN 50082.	5.5.3.2.2.2.3 (28)	R
56	All OTS elements shall meet the EMC/EMI requirements defined in ETSI EN 55022.	5.5.3.2.2.2.3 (29)	R
57	All OTS elements shall meet the EMC/EMI requirements defined in ETSI EN 300-386.	5.5.3.2.2.2.3 (30)	R
58	All OTS elements shall be designed to operate continuously in the following environment ranges without degradation: Temperature: 0 to +50°C; Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.2.2.2.3 (31)	R
59	All OTS elements shall be designed to be fully operational after transportation and/or storage in the following environment ranges: Temperature: -40 to +70°C; Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.2.2.2.3 (32)	R
60	All OTS elements shall be designed to operate continuously in the following environment range without degradation: Altitude: -100 to 15,000 ft above mean sea level (AMSL).	5.5.3.2.2.2.3 (33)	R
61	All OTS elements shall be designed to be fully operational after transportation and/or storage in the following environment range: Transport Altitude: -100 ft to +40,000 ft AMSL.	5.5.3.2.2.2.3 (34)	R
62	All OTS elements shall adhere to NEBS Level 3 compliance standards for acceptable voltage ranges, EMI, and electrostatic discharge (ESD) safety, and shall be operable using standard 48V direct current (dc) power as well as having redundant isolated power input feeds. For certain sites, an alternative alternating current (ac)/dc rectifier may need to be supplied to power the system and shall be able to switch 110/220V with redundant isolated power modules.	5.5.3.2.2.2.3 (35)	R
63	All OTS elements shall be fully operational throughout the battery voltage range of -41.5 to -56 volts direct current (VDC).	5.5.3.2.2.2.3 (36)	R
64	All OTS elements shall not be damaged and recover to normal performance following application of the following maximum transient voltages for the duration's given (nominal voltage 48 VDC): 75 VP-P for 1 msec, 60 VP-P for 500 msec.	5.5.3.2.2.2.3 (37)	R
65	All OTS elements in the transport layer primary operating system interface shall provide the capability for reporting alarms of external equipment and general housekeeping alarms. A minimum of 16 user-defined alarms shall be provided, with the option to expand to 32 user-defined alarm points. Capability shall be provided for a minimum of eight user-defined remote control points for external functions. This capability shall be provided by relays, not Transistor-Transistor Logic	5.5.3.2.2.2.3 (38)	R
66	The OTS shall support having all data cross connects stored locally and redundantly; and automatically restored without user intervention, in the case of failure, within a period of 5 minutes.	5.5.3.2.2.2.3 (39)	R
67	The OTS shall provide the capability to roll back to the previous operational version of software.	5.5.3.2.2.2.3 (40)	R
68	The OTS shall conform to memory administration, and system administration and security standards as documented. (Telcordia Technologies GR-472-CORE and GR-253-CORE (issue 4, December 2005).	5.5.3.2.2.2.3 (41)	R
69	All future software for the OTS shall interoperate with the previous deployed GIG–Bandwidth Expansion (GIG-BE) system operational software version/release.	5.5.3.2.2.2.3 (42)	R
70	The OTS shall support software upgrades that directly use or translate the previous version's configuration database.	5.5.3.2.2.2.3 (43)	R
71	The software of the OTS shall be designed and upgraded in a modular fashion so that an entire code does not have to be replaced when a portion is upgraded.	5.5.3.2.2.2.3 (44)	R
72	The OTS shall be designed with an accessible file system to allow for multiple versions of software, logs, and file manipulation or integrity checks to be performed before upgrading or downgrading software and/or firmware.	5.5.3.2.2.2.3 (45)	R
73	All equipment shall have been tested and registered as compliant to the following electrical safety standards: UL-1950, EN60950, and International Electrotechnical Commission (IEC) 60950.	5.5.3.2.2.2.3 (46)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
	Protection and Restoration	**5.5.3.2.2.4**	
74	The OTS shall support 1+1 wavelength protection and restoration.	5.5.3.2.2.4 (1)	R
75	The “Active” and “Standby” wavelengths shall be diversely routed.	5.5.3.2.2.4 (2)	R
	Optical Amplifier	**5.5.3.2.3**	
76	The system shall support the use of an optical connector for connecting an optical amplifier (OA) to the outside plant fiber; Raman amplifiers may not be directly spliced to the transmission fiber and must be field-replaceable, without the need for special equipment.	5.5.3.2.3 (1)	R
77	The total optical power emitted from the OTS to be coupled into the fiber, shall not exceed the power limit of IEC Class 3B (+27 dBm).	5.5.3.2.3 (2)	R
78	The OTS shall monitor and report on the operation of the Raman pumping lasers including power on, off, optical output power, operating current, and total ORL.	5.5.3.2.3 (3)	R
79	Once detecting the failure of Raman pumping lasers, the OTS shall generate an alarm, but shall not shut off the system.	5.5.3.2.3 (4)	R
80	The Raman pumping lasers shall automatically shut off if a fiber is broken or a connector disconnected in the span pumped by the Raman amplifier.	5.5.3.2.3 (5)	R
81	The OTS shall have an integrated power management algorithm, which invokes power monitoring and adjustment devices to compensate for power variations across the optical wavelengths.	5.5.3.2.3 (6)	R
82	The OLA system shall be able to balance individual wavelengths so that power output levels exhibit less than 0.5 dB variance from the mean output level without remote or direct intervention from a network operator.	5.5.3.2.3 (7)	R
83	When one or more channels fail or are removed, the remaining channels shall not experience increased bit errors or loss of operating margin.	5.5.3.2.3 (8)	R
84	When failed channels are restored or new channels are added, the existing channels shall not experience any transient or long-term performance deterioration.	5.5.3.2.3 (9)	R
85	The power management algorithm shall cause no interruptions in OSC communications at any time.	5.5.3.2.3 (10)	R
86	OSC signals shall experience no increased errors at any time up to EOL, including during wavelength provisioning or line equalization.	5.5.3.2.3 (11)	R
87	Amplifiers shall require less than 1 ms to return all wavelength power output levels to within 1 dB of pre-insertion/drop levels – transient suppression statistics shall be provided for OLA systems.	5.5.3.2.3 (12)	R
88	The OA shall maintain safe (Hazard level 1) system operation in the event of input signal loss or fiber cut.	5.5.3.2.3 (13)	R
89	Chromatic dispersion compensation shall be able to fully compensate a 150 km span for each fiber type, as specified in the fiber requirements section.	5.5.3.2.3 (14)	R
90	Chromatic dispersion compensation shall be provided for different fiber lengths in 10, 20, or 30 km increments, if the technique requires the compensation to be periodically dispersed.	5.5.3.2.3 (15)	R
91	The OTS shall enable pre- and post- dispersion compensation options.	5.5.3.2.3 (16)	R
92	A secured external monitor port is required at each OA. For devices that contain a full-featured internal Optical Spectrum Analyzer (OSA), an external monitor port shall still be required.	5.5.3.2.3 (17)	R
93	Internal OSA functionality shall support 25 GHz ITU grid spacing with minimum 5 percent wavelength accuracy.	5.5.3.2.3 (18)	C
94	Internal OSA functionality shall provide a minimum accuracy of 0.2 dB for each wavelength.	5.5.3.2.3 (19)	R
95	Internal OSAs shall provide sweep times of less than 1 second.	5.5.3.2.3 (20)	R
96	Internal OSAs shall provide the ability to display all wavelengths simultaneously.	5.5.3.2.3 (21)	R
97	Internal OSAs shall provide the ability to retrieve data to be stored at a remote storage site.	5.5.3.2.3 (22)	R
98	Internal OSAs shall provide the ability to view various calculated data such as gain tilt, output tilt, gain variation, gain difference, noise level, total received power, total launched power, etc.	5.5.3.2.3 (23)	R
99	Internal OSAs shall provide the ability to report Q factor (not critical).	5.5.3.2.3 (24)	R
100	Internal OSAs shall have the ability to show eye diagrams (not critical).	5.5.3.2.3 (25)	R
101	Internal OSAs shall have the ability to estimate Optical Signal to Noise Ratio (OSNR) for each wavelength.	5.5.3.2.3 (26)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
102	All measurements made available at the internal OSA shall be available at the external OSA port (not critical).	5.5.3.2.3 (27)	R
	OLA Physical Design Requirements	**5.5.3.2.3.1**	
103	The total optical power emitted from the OTS to be coupled into the fiber, shall not exceed the power limit of IEC Class 3B (+27 dBm).	5.5.3.2.3 (2)	R
104	The OTS shall monitor and report on the operation of the Raman pumping lasers including power on, off, optical output power, operating current, and total ORL.	5.5.3.2.3 (3)	R
105	The OLA shall support hot swappable modular components, including but not limited to fans, amplifier modules, in-band/out-of-band management interfaces, power supplies, and control processor.	5.5.3.2.3.1 (1)	R
106	The OLA shall support redundant Fans Management Interfaces Power Supplies Control Processors	5.5.3.2.3.1 (2)	R
107	The OA shall be able to fit into either a 19" or a 23" rack with depth no greater than 30" and height no more than 84".	5.5.3.2.3.1 (3)	R
108	The OLA overall dimensions shall be no more than one 7.2-foot standard Telco rack for a full 80 wavelengths bi-directionally, or two racks for 160 wavelengths, including out-of-band management functions.	5.5.3.2.3.1 (4)	R
109	The OLA power consumption shall be kept below 2,000 watts for all equipment at an OLA site.	5.5.3.2.3.1 (5)	R
110	The vendor shall identify their OLA power and space requirements for all specified configurations.	5.5.3.2.3.1 (6)	R
	Muxponder Requirements	**5.5.3.2.4**	
111	Transponders shall support a four-to-one muxponder (4-10G signals multiplexed into one 40G signal). If the vendor equipment supports this functionality, the equipment shall meet the requirements listed in this section (3.2.1.3).	5.5.3.2.4 (1)	R
112	The OTS shall support a 4:1 40G multiplexer (MUX). The 4:1 40G MUX shall receive four standards compliant OC-192/STM-64 signals, from one to four sources, and multiplex them onto a signal for transport over a 40G wavelength on the system.	5.5.3.2.4 (2)	R
113	The 4:1 40G MUX shall transmit a 40G channel in each of the operating bands specified by the vendor. The vendor shall indicate any excluded band.	5.5.3.2.4 (3)	R
114	The 4:1 40G MUX shall occupy no more physical space than an OC-192/STM-64 transmit/receive pack.	5.5.3.2.4 (4)	R
115	The 4:1 40G MUX shall transfer the OC-192/STM-64 signals through the system transparently.	5.5.3.2.4 (5)	R
116	The engineering rules for the 4:1 40G MUX configuration shall be the same as the standard OC-768/STM-256 configuration without the need to change any system components, including dispersion compensation.	5.5.3.2.4 (6)	R
117	The OC-192/STM-64 interface (i.e. SR, etc.) for a 4:1 40G MUX shall have identical compliance to all of the requirements for an OC-192/STM-64 interface to an OC-192/STM-64 standard transponder as specified in this document.	5.5.3.2.4 (7)	R
118	An OC-48/STM-64 through the OTS that is multiplexed and demultiplexed through the 4:1 10G MUX shall meet the same performance requirements as an OC-192/STM-64 signal through the OTS using OC-192/STM-64 transponders. Performance requirements include, but are not limited to BER, Errored Seconds (ES), Severely Errored Seconds (SES), and Availability.	5.5.3.2.4 (8)	R
119	An OC-192/STM-64 through multiple concatenated systems containing 4:1 10G MUX shall meet the same performance requirements as an OC-192/STM-64 signal through concatenated OTSs using OC-192/STM-64 transponders. The same number of concatenated 4:1 10G MUX shall be supported as the number of concatenated OC-192/STM-64 transponders. Performance requirements include, but are not limited to Jitter Generation and Tolerance.	5.5.3.2.4 (9)	R
120	The maximum number of 40G channels equipped with 4:1 40G MUX in an OTS must be equal to the maximum number of OC-768/STM-256 channels supported in an OTS.	5.5.3.2.4 (10)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
121	The 4:1 10G MUX shall operate without degradation if less than four of the OC-192/STM-64s have a valid OC-192/STM-64 signal.	5.5.3.2.4 (11)	R
122	The loss of one or more provisioned OC-192/STM-64 inputs to a 4:1 10G MUX shall not affect the performance of any other provisioned OC-192/STM-64 on that multiplexed channel.	5.5.3.2.4 (12)	R
	Transponder Requirements	**5.5.3.2.5**	
123	Transponders shall comply with the DWDM wavelength grid as specified in ITU-T G.694.1.	5.5.3.2.5 (1)	R
124	Transponders shall support tunable lasers, which are tunable over whole band.	5.5.3.2.5 (2)	R
125	All transponders shall support built-in self BER test function	5.5.3.2.5 (3)	R
126	All transponders shall support local and remote loop-back capability on the line side for built-in self-BER test.	5.5.3.2.5 (4)	R
127	All transponders shall support total end-to-end (E2E) signal propagation delay (at transponder ingress to egress) reporting function.	5.5.3.2.5 (5)	C
128	All transponders shall support User selectable line side FEC (Forward Error Correction), i.e., no FEC, ITU-T G.709 compliant standard FEC, and enhanced FEC SFEC or EFEC modes.	5.5.3.2.5 (6)	R
129	Transponders shall support ITU-T G.709 specifications for OTN services.	5.5.3.2.5 (7)	R
130	Transponders shall support switching of framing protocols (OTN, SONET, 10GBE, etc.) without requiring downloading or switching firmware/software and physical removal of the transponder from the slot.	5.5.3.2.5 (8)	R
131	Transponders shall have non-intrusive SONET/SDH B1 monitoring capability	5.5.3.2.5 (9)	R
132	Transponder shall have integrated EDC (Electronic Dispersion Compensation) for all specified fiber types to support minimum un-regenerated reach of 2000 kms.	5.5.3.2.5 (10)	C
133	The vendor shall supply through-transponder(s) to eliminate unnecessary O/E conversions for wavelength regeneration at ROADM, OXC, and regenerator sites.	5.5.3.2.5 (11)	R
134	The vendor shall provide a transponder to interface with 10/40/100Gbps unframed wavelength services.	5.5.3.2.5 (12)	R
135	A transponder shelf shall support all types of transponders, or a combination of them. No slot shall be bit-rate specific.	5.5.3.2.5 (13)	R
136	There shall be no human (manual) tuning or intervention (such as power or wavelength adjustment) involved after adding transponders.	5.5.3.2.5 (14)	R
137	A transponder shall support all wavelengths and required transmission rates with a minimum reach of 2000 kilometers without O-E-O regeneration on all specified fiber types (e.g., ITU-T G.652, G.655).	5.5.3.2.5 (15)	R
	Interface Requirements	**5.5.3.2.5.1**	
138	Transponders shall support an OC-48/STM-16 interface.	5.5.3.2.5.1 (1)	R
139	Transponders shall support an OC- 192/STM64 interface.	5.5.3.2.5.1 (2)	R
140	Transponders shall support a GigE interface.	5.5.3.2.5.1 (3)	R
141	Transponders shall support a 10GigE WAN PHY interface.	5.5.3.2.5.1 (4)	R
142	Transponders shall support a 10GigE LAN PHY interface.	5.5.3.2.5.1 (5)	R
143	The transponders shall support OC- 768/STM256 interfaces.	5.5.3.2.5.1 (6)	R
144	The transponder shall support all OTN rates including ODU1/ODU2/ODU3 and 100Gbs in future.	5.5.3.2.5.1 (7)	R
145	The transponders shall support Short Reach (SR), Long Reach (LR-1, LR-2, LR-3), and Intermediate Reach (IR-1, IR-2), client interface types per Telcordia Technologies GR-253-CORE.	5.5.3.2.5.1 (8)	R
146	The transponders shall support client interfaces at 1310 and 1550 nm.	5.5.3.2.5.1 (9)	R
147	The transponders shall support client interface at 850 and 1310 nm for GigE signals.	5.5.3.2.5.1 (10)	R
	ROADM	**5.5.3.2.6**	
148	The ROADM shall be capable of supporting a minimum of eight network-side interfaces, perform both optical bypass, and add/drop functions.	5.5.3.2.6 (1)	R
149	The ROADM shall support direction-less wavelength routing.	5.5.3.2.6 (2)	R
150	The ROADM shall be capable of colorless wavelength routing.	5.5.3.2.6 (3)	R
151	The system shall support cascading of minimum eight ROADMs for a total un-regenerated reach of 2000 kms.	5.5.3.2.6 (4)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
152	Any wavelength not explicitly dropped or added shall be passed through the ROADM.	5.5.3.2.6 (5)	R
153	It shall be possible to reuse wavelength at ROADM.	5.5.3.2.6 (6)	R
154	There shall be no restrictions on ADD/DROP and EXPRESS (pass through) wavelengths at ROADM site.	5.5.3.2.6 (7)	R
155	It shall be possible to add/drop, or pass express, any of the optical channels at an ROADM site in any order.	5.5.3.2.6 (8)	R
156	If a wavelength is dropped at an ROADM site, then the same wavelength shall be able to be added at that site. However, there shall be no requirement that the wavelength that is dropped must be matched by a corresponding wavelength that is added, and vice versa, implying wavelength translation capability at the ROADM. At a ROADM it shall be possible to drop an incoming wavelength and not add a new corresponding outgoing wavelength including the following: a. Accepting a non-provisioned incoming wavelength and adding a new outgoing wavelength. b. Dropping an incoming wavelength and adding a new corresponding outgoing wavelength	5.5.3.2.6 (9)	R
157	The ROADM shall be capable of supporting dynamic wavelength selection without pre-cabling being required.	5.5.3.2.6 (10)	R
158	The ROADM shall be capable of dropping all wavelengths from each of eight line-side fiber connections to tributary side optics.	5.5.3.2.6 (11)	R
159	The ROADM shall be capable of adding all wavelengths to each of eight line-side fiber connections from tributary side optics	5.5.3.2.6 (12)	R
160	The ROADM shall be capable of dropping any specific wavelength, independent of other wavelengths to be dropped.	5.5.3.2.6 (13)	R
161	The ROADM shall be capable of adding any specific wavelength, independent of other wavelengths to be added.	5.5.3.2.6 (14)	R
162	The ROADM shall support wavelength hair-pinning capability.	5.5.3.2.6 (15)	R
163	The ROADM shall support wavelength regeneration, including wavelength conversion, using back-to-back transponders or through-transponders via hair pinning.	5.5.3.2.6 (16)	R
164	The activation of additional services on interfaces in the ROADM shall be non-service affecting to existing traffic and shall not cause any increase in bit-errors.	5.5.3.2.6 (17)	R
165	The deletion of active services on interfaces in the ROADM shall be non-service affecting to the remaining traffic and shall not cause any increase in bit-errors.	5.5.3.2.6 (18)	R
166	Hardware upgrades of the ROADM to support higher tributary interface density shall not disrupt operational traffic.	5.5.3.2.6 (19)	R
167	Hardware upgrades of the ROADM to support higher line interface density shall not disrupt operational traffic.	5.5.3.2.6 (20)	R
168	The ROADM shall provide latching capability. (Latching is the ability of the ROADM to maintain its current state in the event of power failure.)	5.5.3.2.6 (21)	R
169	The ROADM shall provide optical multicasting capability. (Multicasting is the ROADM's ability to allow one input wavelength to be duplicated on multiple outputs tributary and line ports).	5.5.3.2.6 (22)	R
170	The ROADM shall support dynamic per-wavelength power leveling.	5.5.3.2.6 (23)	R
171	The addition or deletion of a wavelength service on the ROADM shall not cause an increase in BER or data loss on other wavelengths.	5.5.3.2.6 (24)	R
172	The ROADM shall not incur increased bit errors associated with wavelength provisioning or line equalization.	5.5.3.2.6 (25)	R
173	The failure of an upstream line system shall not cause the ROADM to increase in BER or lose data on the remaining active wavelengths.	5.5.3.2.6 (26)	R
174	The OSNR (optical signal to noise ratio) penalty for any signal passing thru a ROADM shall be < 0.5 dB.	5.5.3.2.6 (27)	R
175	The system is required to automatically redirect working paths to available spare fibers/wavelengths in the event of a primary path failure. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (28)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
176	The ROADM shall support 1+1 protection functionality with fully diverse routing. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (29)	R
177	The switching time for 1+1 protection shall be ≤ 50 ms. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (30)	R
178	The switching time for 1+1 protection shall be ≤ 20 ms. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (31)	R
179	The ROADM shall support redirection of light paths via the EMS/NMS.	5.5.3.2.6 (32)	R
180	The ROADM shall support linear protection topologies. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (33)	R
181	The ROADM shall support ring protection topologies. The ROADM shall not inhibit ring or linear protection switching initiated by ODXC, MSPP or other electronic device.	5.5.3.2.6 (34)	R
	ROADM Specific Physical Design Requirements	**5.5.3.2.6.1**	
182	The vendor shall comply with all requirements listed in General Physical Requirements of this document. The vendor shall list all discrepancies.	5.5.3.2.6.1 (1)	R
183	The ROADM shall support hot swappable modular components, including but not limited to: Fans Switch Fabric Interface Ports Power Supplies Control Processor.	5.5.3.2.6.1 (2)	R
184	The ROADM shall support redundant: Fans Switching Fabrics Power Supplies Control Processors.	5.5.3.2.6.1 (3)	R
185	The ROADM equipment shall be able to fit in either a 19" or a 23" rack with depth no greater than 32" and height no more than 84".	5.5.3.2.6.1 (4)	R
186	The fully configured ROADM (excluding the transponder shelves) shall not exceed two full 84" racks.	5.5.3.2.6.1 (5)	R
187	The fully configured ROADM shall not exceed one full 84" rack.	5.5.3.2.6.1 (6)	R
188	The ROADM shall not require contiguous rack locations.	5.5.3.2.6.1 (7)	R
189	The ROADM weight shall be such that the device can be mountable in a standard Telco™ rack or secure cabinet with standard rack screws and not require unusual hardware.	5.5.3.2.6.1 (8)	R
	Requirements Common to Transponder and ROADM	**5.5.3.2.7**	
	Framed Formats	**5.5.3.2.7.1**	
190	The OTS shall support the transport of the following SONET/SDH services: OC-192/STM-64, OC-48/STM-16, and OC-768/STM256.	5.5.3.2.7.1 (1)	R
191	The OTS shall support the transport of the following Ethernet services: GigE (via 10:1 Muxponder), 10GigE WAN PHY, and 10GigE LAN PHY.	5.5.3.2.7.1 (2)	R
192	The OTS shall support the transport of the following OTN services: OTU-1, OTU-2, and OTU-3.	5.5.3.2.7.1 (3)	C
193	The OTS shall be transparent to the bit pattern of all optical channels (i.e., the OTS shall not modify the payload bit pattern of any signal that traverses it).	5.5.3.2.7.1 (4)	R
194	Framed wavelength services shall be supported for 2.5, 10, and 40 Gbps SONET/SDH and OTN transport (ITU-T G.709).	5.5.3.2.7.1 (5)	R
195	Framed wavelength services shall be supported for GigE/10 GigE signals, and signals formatted for OTN transport (ITU-T G.709).	5.5.3.2.7.1 (6)	R
196	Framed wavelength services shall be supported for 40 (ITU-T G.709) and 100 Gbps (STD TBD) signals.	5.5.3.2.7.1 (7)	R
197	The OTS shall support, in hardware and in software, the possibility to feed a specified ITU-T grid wavelength, with undefined framing, directly into the multiplexer through a “colored interface” that shall verify the wavelength and power levels (commonly known as ALIEN wavelength). Identify other characteristics of the tributary signal required to be known and monitored for proper OTS system operation with such tributary signals.	5.5.3.2.7.1 (8)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
198	Alien wavelength" regeneration shall be supported.	5.5.3.2.7.1 (9	R
	Unframed Formats	**5.5.3.2.7.2**	
199	The OTS shall support unframed wavelength services.	5.5.3.2.7.2 (1)	R
200	The OTS shall support mixed framed service unframed wavelength service	5.5.3.2.7.2 (2)	R
	Optical Supervisory Channel	**5.5.3.2.8**	
201	The OLA, ROADM, end terminal (ET) elements shall terminate/insert an Optical Supervisory Channel (OSC) with a wavelength that adheres to ITU-T specifications.	5.5.3.2.8 (1)	R
202	The OLA, ROADM, and ET elements shall utilize the ITU-T specified OSC for out-of-band management communications.	5.5.3.2.8 (2)	R
203	The OLA, ROADM, and ET elements shall use the same OSC wavelength.	5.5.3.2.8 (3)	R
204	The internal diagnostics for OLA, ROADM, and ET elements shall report OSC failure.	5.5.3.2.8 (4)	R
205	It shall be possible to turn-up and sustain transmission between two nodes in the absence of an OSC.	5.5.3.2.8 (5)	R
206	The OLA, ROADM, and ET elements shall report any OSC channel input/output failure (via out-of-band DCN).	5.5.3.2.8 (6)	R
207	The OLA, ROADM, and ET elements shall report any OSC channel BER threshold violation.	5.5.3.2.8 (7)	R
208	The OLA, ROADM, and ET elements shall provide OSC interfaces that allow for interoperability with all adjacent equipment within the optical network (wavelength, modulation, protocol, etc) from the same vendor.	5.5.3.2.8 (8)	R
209	The OSC shall be able to operate error-free across 150 km of each specified fiber type with a span loss of 50 dB at the OSC frequency/wavelength. The span loss shall not be inclusive of the OSC insertion loss.	5.5.3.2.8 (9)	R
210	The OSC circuit-pack shall report optical span-loss between two adjacent nodes.	5.5.3.2.8 (10)	R
211	The OSC shall operate at 2 Mb/s or higher data rates.	5.5.3.2.8 (11)	R
212	Architecturally, the OSC shall be passively and optically separated from the transport optical signals immediately after input connection of the OTS.	5.5.3.2.8 (12)	R
	OTS Standards Compliance Requirements	**5.5.3.2.9**	
213	ITU-T G.652, "Characteristics of a single-mode optical fiber and cable."	5.5.3.2.9 (1)	R
214	ITU-T G.655, "Characteristics of a non-zero dispersion-shifted single-mode optical fiber and cable."	5.5.3.2.9 (2)	R
215	ITU-T 694.1, "Spectral grids for WDM applications: DWDM frequency grid."	5.5.3.2.9 (3)	R
216	ITU-T G.709/Y.1331, "Network node interface for the optical transport network (OTN)."	5.5.3.2.9 (4)	R
217	ITU-T G.958, "Digital line systems based on the synchronous digital hierarchy for use on optical fiber cables." [Withdrawn]	5.5.3.2.9 (5)	R
218	ITU-T G.8251 (G.otnjit), "The control of jitter and wander within the optical transport network (OTN)."	5.5.3.2.9 (6)	R
219	Telcordia Technologies GR-63-CORE, Network Equipment-Building System (NEBS™) Generic Equipment Requirements.	5.5.3.2.9 (7)	R
220	Telcordia Technologies TR-NWT-000179, Quality Systems Generic Requirements for Software.	5.5.3.2.9 (8)	R
221	Telcordia Technologies GR-253-CORE, Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria.	5.5.3.2.9 (9)	R
222	Telcordia Technologies GR-282-CORE, Software Reliability and Quality Acceptance Criteria (SRQAC).	5.5.3.2.9 (10)	R
223	Telcordia Technologies TR-NWT-000295, Isolated Ground Planes: Definition and Application to Telephone Central Offices.	5.5.3.2.9 (11)	R
224	Telcordia Technologies NWT-000418, Reliability Assurance for Fiber Optic Systems.	5.5.3.2.9 (12)	R
225	Telcordia Technologies GR-472-CORE, Network Element Configuration Management.	5.5.3.2.9 (13)	R
226	Telcordia Technologies FR-796, Reliability and Quality Generic Requirements (RQGR).	5.5.3.2.9 (14)	R
227	Telcordia Technologies GR-1089-CORE, Electromagnetic Compatibility, and Electrical Safety - Generic Criteria for Network Telecommunications Equipment.	5.5.3.2.9 (15)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
228	Telcordia Technologies SR-NWT-002419, Software Architecture Review Checklists.	5.5.3.2.9 (16)	R
229	Telcordia Technologies GR-2911-CORE, Software Inventory for Network Element Software Management.	5.5.3.2.9 (17)	R
230	ETSI ETS 300 019, "Equipment Engineering (EE); Environmental Conditions and Environmental Tests for Telecommunications Equipment."	5.5.3.2.9 (18)	R
231	ETSI ETS EN 50022, "Specification for low voltage switchgear and control gear for industrial use."	5.5.3.2.9 (19)	R
232	ETSI EN 50082, "Electromagnetic compatibility. Generic immunity standard. Residential, commercial and light industry."	5.5.3.2.9 (20)	R
233	ETSI EN 300 386, "Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; Electromagnetic Compatibility (EMC) requirements."	5.5.3.2.9 (21)	R
234	BS EN 60950-1 Information Technology Equipment – Safety – Part 1: General Requirements.	5.5.3.2.9 (22)	R
235	IEC 60950-1 Information Technology Equipment – Safety – Part 1: General Requirements.	5.5.3.2.9 (23)	R
236	CFR FCC Part 15, Class A.	5.5.3.2.9 (24)	R
237	NEBS, Level 3.	5.5.3.2.9 (25)	R
238	Underwriters Laboratories, Inc. UL-1950, Standard for Safety, Information Technology Equipment Including Electrical Business Equipment.	5.5.3.2.9 (26)	R
239	EIA 310C, 19-inch rack mounting equipment specification.	5.5.3.2.9 (27)	R
	Transport Switch Function (TSF)	**5.5.3.3**	
	TSF SONET/SDH Interface Requirements	**5.5.3.3.2**	
240	The TSF shall support SDH or SONET on any combination of ports or port cards.	5.5.3.3.2 (1)	R
241	It shall be possible to use any port on the systems as network-side interfaces or tributary-side interfaces.	5.5.3.3.2 (2)	R
242	The network-side interfaces shall include OC-768/STM-256 (if supported), OC-192/STM-64, OC-48/STM-16, and OC-12/STM-4.	5.5.3.3.2 (3)	R
243	The tributary-side interfaces shall include OC-48/STM-16, OC-12/STM-4, and OC-3/STM-1.	5.5.3.3.2 (4)	R
244	The network-side interfaces shall include 10 Gbps DWDM using the ITU grid (C and L band).	5.5.3.3.2 (5)	D
245	The TSF shall provide optical interfaces for OC-192, OC-48, OC-12, and OC-3 signals consistent with the SR-1, IR-1, IR-2, LR-1, LR-2, and LR-3 application specifications of Telcordia Technologies GR-253-CORE, Section 4.	5.5.3.3.2 (6)	R
246	The TSF shall provide optical interfaces for OC-768 signals consistent with the SR-1, IR-1, IR-2, LR-1, LR-2, and LR-3 application specifications of Telcordia Technologies GR-253-CORE, Section 4.	5.5.3.3.2 (7)	D
247	The TSF shall provide optical interfaces for OTU-1, OTU-2, and OTU-3 optical signals consistent with the application specifications of ITU-T Recommendation G.709.	5.5.3.3.2 (8)	D
248	The TSF shall provide optical interfaces for STM-256, STM-64, STM-16, STM-4, and STM-1 signals consistent with the application codes I-n, S-n.x, and L-n.x in ITU-T Recommendation G.957. There should be no differences between single-channel optical interfaces for SONET terminations according to Telcordia Technologies GR-253-CORE and the level-comparable SDH optical interfaces specified in ITU-T Recommendation G.957-CORE.	5.5.3.3.2 (9)	R
249	The TSF shall support the SR-1 interface and at least one of the IR-1, IR-2, or IR-3 interface for OC-3, OC-12, OC-48, and OC-192 signals consistent with the requirements in this document.	5.5.3.3.2 (10)	R
250	The TSF shall support the SR-1 interface and at least one of IR-1, IR-2, or IR-3 interface for OC-768 signals consistent with the requirements elsewhere in this document.	5.5.3.3.2 (11)	D
251	The TSF shall support the Intraoffice (I-x) interface and any Short-haul (S-n.x) interface for STM-1 (if supported), STM-4, STM-16, STM-64, and STM-256 (if supported) signals consistent with the requirements in this document.	5.5.3.3.2 (12)	R
252	The OC-192 SONET/STM-64 interfaces shall support Very Short Reach (VSR) optics as defined in ITU-T Recommendation G.693.	5.5.3.3.2 (13)	D

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
253	The TSF shall support the capability to provide physical loopback toward the line side and cross-connect matrix for all supported interfaces.	5.5.3.3.2 (14)	R
	TSF Ethernet Interface Requirements	**5.5.3.3.3**	
254	The TSF shall provide interfaces for Gigabit Ethernet Services in conformance with the IEEE 802.3 for Ethernet LAN interfaces. The Logical Link Interworking Function (IWF) shall terminate the Media Access Control (MAC) layer of Ethernet as described in the Ethernet Standard IEEE 802.3.	5.5.3.3.3(1)	R
255	The TSF interfaces shall include 100 Gigabit Ethernet consistent with the application specifications of IEEE 803.	5.5.3.3.3 (2)	D
256	The TSF shall provide interfaces for 10 Gigabit Ethernet Services in conformance with the IEEE 802.3ae for Ethernet WAN PHY interfaces. The Logical Link IWF shall terminate the MAC layer of Ethernet as described in the Ethernet Standard IEEE 802.3.	5.5.3.3.3 (3)	R
257	The Gigabit Ethernet interfaces shall accommodate Ethernet packets greater than 4470 bytes.	5.5.3.3.3 (5) (no#4)	R
258	The 10 Gigabit Ethernet interfaces shall accommodate Ethernet packets greater than 4470 bytes.	5.5.3.3.3 (6)	R
259	The TSF shall be able to provision, monitor, and detect faults on, and restore Gigabit Ethernet services in a standardized and automated fashion.	5.5.3.3.3 (7)	R
260	The TSF shall be able to provision, monitor, and detect faults on, and restore 10 Gigabit Ethernet services in a standardized and automated fashion.	5.5.3.3.3 (8)	R
261	The TSF's Ethernet services shall support both port-based and flow-based Virtual LANs (VLANs) for multiple rates and customer interfaces as defined by IEEE Standard 802.1Q-1998, Virtual Bridged Local Area Networks.	5.5.3.3.3 (9)	R
262	The TSF shall not, by default, perform any Layer 3 routing.	5.5.3.3.3 (10)	R
263	The TSF shall support VLAN Tagging as specified by IEEE 802.1Q.	5.5.3.3.3 (11)	R
264	The TSF shall selectively provide point-to-point Ethernet services with dedicated non-shared bandwidth without queuing or buffering of Ethernet frames.	5.5.3.3.3 (12)	R
265	The TSF shall support ITU-T Recommendation G.7041/Y.1303 (2003).	5.5.3.3.3 (13)	R
266	The TSF shall support ITU-T Recommendation G.7043/Y.1343 (2004).	5.5.3.3.3 (14)	R
267	The TSF shall support ITU-T Recommendation G.7042/Y.1305 (2004).	5.5.3.3.3 (15)	R
268	GE VCSA interface according to ITU-T Recommendation G.7042 [	5.5.3.3.3 (16)	R
269	The TSF shall support OTU-1 and OTU-2 interfaces according to ITU-T Recommendation G.709.	5.5.3.3.3 (17)	D
270	The TSF shall support OTU-3 interface according to ITU-T Recommendation G.709.	5.5.3.3.3 (18)	D
	TSF Framing Requirements	**5.5.3.3.4**	
271	The TSF shall conform to the standard SONET STS-1, STS-N, and STS-Nc frame structures per Telcordia Technologies GR-253-CORE.	5.5.3.3.4 (1)	R
272	The TSF shall conform to the standard SDH optical interfaces, rates and formats documented in ITU-T Recommendation G.707 for each of the following optical interfaces: STM-1, STM-4, STM-16, and STM-64.	5.5.3.3.4 (2)	R
273	The TSF shall conform to the standard OTU optical interfaces, rates and formats documented in ITU-T Recommendation G.709 for each of the following optical interfaces: OTU-1, OTU-2, and OTU-3.	5.5.3.3.4 (3)	D
274	All SONET overhead bytes are to be defined, generated, and processed according to the specifications of Telcordia Technologies GR-253-CORE. All SDH overhead bytes are to be defined, generated, and processed according to the specifications of ITU-T Recommendation G.707.	5.5.3.3.4 (4)	R
275	All OTU overhead bytes are to be defined, generated, and processed according to the specifications of ITU-T Recommendation G.709.	5.5.3.3.4 (5)	D
276	If any SONET/SDH overhead bytes are used for proprietary purposes, it shall be possible to ignore these bytes at the receive side without affecting any transmission capability described in Telcordia Technologies GR-253-CORE or in ITU-T Recommendation G.783, respectively.	5.5.3.3.4 (6)	R
277	The capability to read or write the 16-byte frame and format of ITU-T Recommendation G.707 and clause 3 of ITU-T Recommendation G.831 shall be provided for both the Section Trace (J0) and the Path Trace (J1) bytes.	5.5.3.3.4 (7)	R
278	The capability to read or write the 64-byte frame and format of ITU-T Recommendation G.707 and clause 3 of ITU-T Recommendation G.831 shall be provided for both the Section Trace (J0) and the Path Trace (J1) bytes.	5.5.3.3.4 (8)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
	TSF Switch Fabric Requirements	**5.5.3.3.5**	
279	The SONET cross-connects shall have an STS-1 granularity.	5.5.3.3.5 (1)	R
280	The SDH cross-connects shall have a Virtual Circuit (VC) VC-3 VC-4 granularity.	5.5.3.3.5 (2)	R
281	The TSF shall not modify the user payload. Except for internetworking functions associated with optional Ethernet services, the system shall not perform any user protocol conversions.	5.5.3.3.5 (3)	R
282	The TSF shall not impart any errors onto the connections during cross-connects, grooming, or multiplexing.	5.5.3.3.5 (4)	R
283	The TSF shall support virtual concatenation as defined in ANSI T1.105-2001 or ITU-T Recommendation G.707.	5.5.3.3.5 (5)	R
284	No single failure in the switch fabric shall affect service. The system shall meet Telcordia Technologies GR-2996-CORE requirements for fabric availability.	5.5.3.3.5 (6)	R
285	The interface cards shall be capable of switching between the working and protection switch fabric in an errorless manner for manual operation, and in a hitless manner for automated operation. No bits shall be lost or corrupted with errorless switching. Bit errors are allowed with hitless switching. However, hitless switching shall not cause downstream reframing to occur.	5.5.3.3.5 (7)	R
	TSF Performance Requirements	**5.5.3.3.6**	
286	The TSF shall meet the jitter criteria for SONET systems in Telcordia Technologies GR-25-CORE, Section 5.6.	5.5.3.3.6 (1)	R
287	The TSF shall meet the jitter criteria for SDH systems according to ITU-T Recommendation G.825.	5.5.3.3.6 (2)	R
288	The TSF shall meet the interface jitter criteria specified for User Network Interfaces (UNIs) for ITU-T OTNs.	5.5.3.3.6 (3)	R
289	The jitter tolerance measured at the OC-N interface on the switch shall meet input jitter tolerance specification documented in ANSI T1.105.03-1994.	5.5.3.3.6 (4)	R
290	The jitter generation measured at an OC-N interface on the switch shall be less than 0.01 Unit Interval Root Mean Square (UIrms) when measured using a high-pass filter with 12-kilohertz (kHz) cutoff frequency as defined in ANSI T1.105.03-1994, Section A.3.3.	5.5.3.3.6 (5)	R
291	The maximum delay for a full STS passed through the Switch or for an STS add/drop from the switch shall not exceed the values defined in Telcordia Technologies GR-2996-CORE.	5.5.3.3.6 (6)	R
292	The TSF shall perform hair-pinning, drop, continue, and drop-and-continue add-drop multiplexing (ADM) functions as specified in Telcordia Technologies GR-496-CORE.	5.5.3.3.6 (7)	D
293	The TSF shall provide the ability to hub or nest lower STSs in a linear or ring configuration from line-side interfaces.	5.5.3.3.6 (8)	D
	General Link Protection Requirements	**5.5.3.3.7**	
294	It shall be possible to provision any SONET port for 1+1 Automatic Protection Switching (APS), 1:N APS; 1:N Optical Protection (OP), 2-fiber Unidirectional Path Switched Ring (UPSR) per Telcordia Technologies GR-1400-CORE, or 2/4-fiber Bidirectional Line Switched Ring (BLSR) per Telcordia Technologies GR-1230-CORE.	5.5.3.3.7 (1)	R
295	It shall be possible to provision any SDH port for 1+1 APS, 0:1 APS, 1:N APS, 1+1 2/4-Fiber Unidirectional Ring, or 2-Fiber Multiplex Section (MS) Shared Protection Ring per ITU-T Recommendation G.841.	5.5.3.3.7 (2)	R
296	When the TSF participates in point-to-point UPSR or BLSR protection, switching shall take place in less than 50 ms. These protection mechanisms shall be definable and selectable from the EMS, and shall offer the selection of revertive and non-revertive restoration mechanisms.	5.5.3.3.7 (3)	R
297	Service restoration via a protection switch shall be automatic and accomplished without human or central management system intervention.	5.5.3.3.7 (4)	R
298	The protection switching mechanism shall be independent among separately managed network domains. A protection switch in one separately managed network domain shall not propagate or relay to another separately managed network domain.	5.5.3.3.7 (5)	R
299	The maximum detection time to determine if a signal's BER threshold is exceeded shall comply with Telcordia Technologies GR-253-CORE and ITU-T G.783.	5.5.3.3.7 (6)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
300	Once a decision is made to switch, the terminal circuit pack switching shall take place within 50 ms, as described in Telcordia Technologies GR-253-CORE and ITU-T Recommendation G.783.	5.5.3.3.7 (7)	R
301	Catastrophic failures on a user-definable Excessive BER (EBER) condition shall be detected by an equipment-protected circuit pack in a terminal within 10 ms as described in Telcordia Technologies GR-253-CORE and ITU-T Recommendation G.783.	5.5.3.3.7 (8)	R
302	When equipped, each TSF shall be compliant with types and characteristics of SDH network protection architectures as defined in ITU-T Recommendation G.841.	5.5.3.3.7 (9)	R
303	When equipped, the TSF shall be compliant with interworking of SDH network protection architectures as defined in ITU-T Recommendation G.842.	5.5.3.3.7 (10)	R
	Linear Protection Requirements	**5.5.3.3.8**	
304	The linear switching protection mechanisms of the TSF shall be selectable as either revertive or non-revertive during network operation.	5.5.3.3.8 (1)	R
305	The SONET linear protection mechanisms of the TSF including APS functions, shall conform to Telcordia Technologies GR-253-CORE. No proprietary APS byte definition and no proprietary linear APS protocol are allowed.	5.5.3.3.8 (2)	R
306	The TSF shall support 1+1 APS optical interface protection, unidirectional and bidirectional, and revertive and non-revertive, per ITU-T Recommendation G.841.	5.5.3.3.8 (3)	R
307	The SDH linear protection mechanisms of the system, including APS functions, shall conform to ITU-T Recommendation G.841. No proprietary APS byte definition or proprietary linear APS protocol is allowed.	5.5.3.3.8 (4)	R
308	When the high-speed interface of the TSF is configured for a linear protection system, it shall support linear protection switching with adjacent equipment. The system shall support both 1+1 and 1:1 protection switching across the network as per Section 5.3.2 of Telcordia Technologies GR-253-CORE and ITU-T Recommendation G.841.	5.5.3.3.8 (5)	R
309	When the TSF is configured as a 1:1 linear protection system, it shall support both unidirectional and bidirectional protection switching capabilities, as described in Telcordia Technologies GR-253-CORE and ITU-T Recommendation G.841.	5.5.3.3.8 (6)	R
310	The maximum length of protection switching time due to a fiber cut, signal failure, user definable EBER, or an equipment circuit pack failure in a network shall not exceed 60 ms per transmission direction, which includes 10 ms BER detection time as described in Telcordia Technologies GR-253-CORE and ITU-T Recommendation G.841.	5.5.3.3.8 (7)	R
311	When the TSF is configured as a 1:1 linear protection system, its default protection switching mode shall be revertive, i.e., the signal shall be automatically reverted to the working fibers after the fibers are repaired and the Wait to Restore (WTR) time has expired, as described in Telcordia Technologies GR-253-CORE. A 1:1 linear system also shall be optionally configurable as non-revertive.	5.5.3.3.8 (8)	R
312	The linear protection configuration of the TSF shall: a. Have a switch completion time in both directions of not more than 50 ms. b. Provide the Signal Fail (SF), Signal Degrade (SD), and APS initiation criteria. c. Support the WTR feature to prevent frequent oscillations between the working and the protection lines resulting from intermittent failures as described in Telcordia Technologies GR-253-CORE. d. Provide a minimum WTR time of 5 minutes. e. Provide a maximum WTR time of 12 minutes as described in Telcordia Technologies GR-253-CORE	5.5.3.3.8 (9)	R
	Ring Protection Requirements	**5.5.3.3.9**	
313	When equipped, the TSF shall be compliant with Telcordia Technologies GR-1230-CORE.	5.5.3.3.9 (1)	R
314	When equipped, the TSF shall be compliant with Telcordia Technologies GR-1400-CORE.	5.5.3.3.9 (2)	R
315	The TSF shall support MS-Shared Protection Ring according to ITU-T Recommendation G.841.	5.5.3.3.9 (3)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
316	The TSF shall support Subnetwork Connection Protection (SNCP) ring protection according to ITU-T Recommendation G.841.	5.5.3.3.9 (4)	R
317	The TSF shall provide the option to use UPSR, 2-fiber BLSR, or 4-fiber BLSR as a ring protection mechanism. When the high-speed interface at a system is configured for any of these protection schemes, it shall support protection switching with other systems in the ring. The maximum length of protection switching time due to a fiber cut, signal failure, user definable EBER, or an equipment circuit pack failure in a network shall not exceed 60 ms per transmission direction, which includes 10 ms BER detection time as described in Telcordia Technologies GR-1230-CORE and GR-1400-CORE.	5.5.3.3.9 (5)	R
318	When the TSF is in a SONET/SDH BLSR configuration, its APS functions shall conform to Telcordia Technologies GR-253-CORE and ITU-T Recommendation G.841. No proprietary APS byte definition and no proprietary ring APS protocol are allowed.	5.5.3.3.9 (6)	R
319	The ring protection configurations of the TSF shall: a. Use standard SONET/SDH ring APS protocols to coordinate the protection switching, as documented in Telcordia Technologies GR-253-CORE and ITU-T Recommendation G.841. b. Complete the protection switch within 50 ms when there is no extra traffic and no previous bridge requests on the ring, and the length of a ring is less than 1200 km of fiber, as described in Telcordia Technologies GR-253-CORE. c. Support a ring size up to at least 16 nodes, as described in Telcordia Technologies GR-253-CORE. d. Not exceed a 50 ms length of hits to service when the following ring configuration functions are performed: Ring Node Addition, Ring Node Deletion, and Ring Segmentation, as described in Telcordia Technologies GR-253-CORE. (When the system is configured as a BLSR system, the protection switch completion time can exceed 50 ms when there is extra traffic or previous bridge requests on the ring, as described in Telcordia Technologies GR-253-CORE).	5.5.3.3.9 (7)	R
	Fault Management Requirements	**5.5.3.3.10**	
320	The TSF shall send the appropriate Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) to adjacent systems, the EMS, and/or the higher level management system after detecting signal failure or degraded conditions for a specified alarm or indication activation time, as described in ANSI T1.231, Tables 2, 6, and 11.	5.5.3.3.10 (1)	R
321	The TSF shall remove the appropriate AIS and RDI after the source system has cleared the signal failure or degraded condition for a specified alarm or indication activation time, as described in ANSI T1.231, Tables 2, 6, and 11.	5.5.3.3.10 (2)	R
322	Alarms shall indicate circuit-level or signal alarms, as well as alarms in the MSPP itself, such as Span Failure, LOS, Path Switch Complete/Fail, Laser Degradation, Card Failure, and Card Mismatch. These conditions will be reported to the EMS and high management system.	5.5.3.3.10 (3)	R
323	Standard SONET and SDH alarms shall be supported by the TSF including LOS, Loss of Pointer (LOP), Loss of Frame (LOF), Receive (Rx) AIS, RDI, and Remote Failure Indication (RFI). These conditions will be reported to the EMS and higher level management system.	5.5.3.3.10 (4)	R
324	The TSF shall indicate SONET T&S failures. The MSPP shall give an alarm showing the inability to establish a Phase Locked Loop (PLL). The MSPP shall have the ability to monitor the Building Integrated Timing Supply (BITS) incoming references (BITS-A and BITS-B). The system shall give an alarm when there is any timing change, e.g., a switch from BITS-A to BITS-B. These conditions will be reported to the EMS and higher level management system.	5.5.3.3.10 (5)	R
325	Each TSF shall detect, report, and clear the following signal failure events or conditions: LOS, LOF, LOP, Severely Errored Framing (SEF), AIS, and Out Of Frame (OOF), according to ANSI T1.231. These events and conditions will be reported to the EMS and higher management system.	5.5.3.3.10 (6)	R
	Performance Management Requirements	**5.5.3.3.11**	
326	The TSF shall calculate the Performance Monitoring (PM) parameter values for each SONET/SDH layer from block errors, rather than bit errors, per ITU-T Recommendation G.826.	5.5.3.3.11 (1)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
327	The TSF shall gather PM data based on overhead bits, such as Bit Interleaved Parity-Number, at the section, line, and path layers, or on Ethernet frame overhead, as appropriate.	5.5.3.3.11 (2)	R
328	The TSF shall track PM data for appropriate service(s), e.g., SONET errors, Far-End Block Errors (FEBE), pointer adjustments; Ethernet statistics. All statistics shall be tracked in 5-minute intervals, with the ability to reduce intervals for testing and analysis.	5.5.3.3.11 (3)	R
329	The TSF shall use tools such as OSAs and optical monitoring tools to verify optical power levels and detect unauthorized signals and other anomalous events on its interfaces.	5.5.3.3.11 (4)	D
330	The TSF shall support status and configuration reporting between nodes in Multi-Ring (Mixed UPSR, BLSR, and 1+1 APS), Linear ADM, Mesh, Regenerator, and Star/Hub node configurations. The NEs shall support near-end and far-end reporting.	5.5.3.3.11 (5)	R
331	The TSF shall support reporting of Resilient Packet Ring (RPR) QoS/CoS parameters.	5.5.3.3.11 (6)	D
332	The TSF shall support reporting of trunk and port quality with user-configurable thresholds.	5.5.3.3.11 (7)	R
333	The TSF shall support reporting of Ethernet frames dropped.	5.5.3.3.11 (8)	R
334	The TSF shall be able to track near-end and far-end statistics in both receive and transmit directions. The MSPP shall be able to track all the performance metrics defined in ITU-T Recommendation M.2101.	5.5.3.3.11 (9)	R
335	The TSF shall monitor each optical interface in accordance with ANSI T1.231-1993. Performance monitoring parameters shall include SEFS, Code Violation (CV), Errored Seconds (ES), SES, Unavailable Seconds (UAS), Protection Switching Counts, and Pointer Justification.	5.5.3.3.11 (10)	R
336	For SONET traffic, the TSF shall be able to track section, line, and path errors. Further, it shall track the respective FEBEs and RDIs.	5.5.3.3.11 (11)	R
337	The TSF shall support intermediate Path Monitoring.	5.5.3.3.11 (12)	D
	EMS Requirements	**5.5.2.2.12 (UCR typo. should be 5.5.3.3.12)**	
338	The TSF EMS shall report PHY (Layer 1) statistics. Further, it shall report layer 2 errors. It shall report all QoS parameters defined for the RPR as described in IEEE 802.17.	5.5.2.2.12 (1)	R
339	The TSF EMS shall be able to track frame errors, P-Bit Parity Errors, C-Bit Parity Errors, and FEBE.	5.5.2.2.12 (2)	R
340	The TSF EMS shall be able to provision the MSPP on all interfaces (i.e., Plesiochronous Digital Hierarchy (PDH)/SONET/SDH/Ethernet) and be able to provision a circuit using the different types of cross-connects (VT1.5, VC-11, VC-12, VC-3, VC-4, STS-1, STM-1, STS-3c, STM-4, STS-12c, STM-16, STS-48c, STM-64, STS-192c, STM-256, and STS-768c).	5.5.2.2.12 (3)	R
341	The TSF EMS shall be able to build protection topologies APS 1+1, UPSR, and BLSR.	5.5.2.2.12 (4)	R
342	The TSF EMS shall be able to provision card parameters required for interoperability to interconnecting carrier systems; SONET/SDH, line loopback, terminal loopback, J0 trace, and J1 trace.	5.5.2.2.12 (5)	R
343	The TSF EMS shall be to provision alarms profiles according to network requirements (i.e., minor, major, critical, none service affecting, and none reporting).	5.5.2.2.12 (6)	R
344	The TSF EMS shall be to review and retrieve alarm and administration logs.	5.5.2.2.12 (7)	R
345	The TSF EMS shall be able to set alarm threshold on any interface (SD and SF).	5.5.2.2.12 (8)	R
346	The TSF EMS shall be able to provision all administrated and security screens based on password level (i.e., network IP address, NE name, user accounts, radius server).	5.5.2.2.12 (9)	R
	Physical Design Requirements	**5.5.3.3.13**	
347	All TSF elements shall meet the EMC/EMI requirements defined in FCC Part 15, Class A.	5.5.3.3.13 (1)	R
348	All TSF elements shall meet the EMC/EMI requirements defined in Telcordia Technologies GR-1089-CORE.	5.5.3.3.13 (2)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
349	All TSF elements shall meet the EMC/EMI requirements defined in ETSI EN 50082.	5.5.3.3.13 (3)	R
350	All TSF elements shall meet the EMC/EMI requirements defined in ETSI EN 55022.	5.5.3.3.13 (4) (Duplicate number 4, with different text below.)	R
351	All TSF elements shall meet the EMC/EMI requirements defined in ETSI EN 300-386.	5.5.3.3.13 (4)	R
352	All TSF elements shall be designed to operate continuously in the following environment ranges without degradation: Temperature: 0 to +50°C; Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.3.13 (5)	R
353	All TSF elements shall be designed to be fully operational after transportation and/or storage in the following environment ranges: Temperature: -40 to +70°C, Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.3.13 (6)	R
354	All TSF elements shall be designed to operate continuously in the following environment range without degradation. Altitude: -100 to 15,000 ft AMSL.	5.5.3.3.13 (7)	R
355	All TSF elements shall be designed to be fully operational after transportation and/or storage in the following environment range: Transport Altitude: -100 ft to +40,000 ft AMSL.	5.5.3.3.13 (8)	R
356	All TSF elements shall adhere to NEBS Level 3 compliance standards for acceptable voltage ranges, EMI, and ESD safety, and shall be operable using standard 48V dc power as well as having redundant isolated power input feeds. For certain sites, an alternative ac/dc rectifier may need to be supplied to power the system and shall be able to switch 110/220-V with redundant isolated power modules.	5.5.3.3.13 (9)	R
357	All TSF elements shall be fully operational throughout the battery voltage range of -41.5 to -56 VDC.	5.5.3.3.13 (10)	R
358	All TSF elements shall not be damaged and recover to normal performance following application of the following maximum transient voltages for the durations given (nominal voltage 48 VDC): 75 VP-P for 1 msec, 60VP-P for 500 msec.	5.5.3.3.13 (11)	R
359	All TSF elements shall be fully NEBS, Level 3 compliant.	5.5.3.3.13 (12)	R
360	All TSF elements shall be designed to operate continuously in the following environment ranges without degradation: Temperature: 0 to +50°C; Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.3.13 (13)	R
361	All TSF elements shall be designed to be fully operational after transportation and/or storage in the following environment ranges: Temperature: -40 to +70°C, Humidity: 5 to 95 percent relative humidity, without condensation.	5.5.3.3.13 (14)	R
362	All TSF elements shall be designed to operate continuously in the following environment range without degradation: Altitude: -100 to 15,000 ft AMSL.	5.5.3.3.13 (15)	R
363	All TSF elements shall be designed to be fully operational after transportation and/or storage in the following environment range: Transport Altitude: -100 ft to +40,000 ft AMSL.	5.5.3.3.13 (16)	R
364	All TSF elements shall adhere to NEBS Level 3 compliance standards for acceptable voltage ranges, EMI, and ESD safety, and shall be operable using standard 48V dc power as well as having redundant isolated power input feeds. For certain sites, an alternative ac/dc rectifier may need to be supplied to power the system and shall be able to switch 110/220 V with redundant isolated power modules.	5.5.3.3.13 (17)	R
365	All TSF elements shall be fully operational throughout the battery voltage range of -41.5 to -56 VDC.	5.5.3.3.13 (18)	R
366	All equipment shall have been tested and register as compliant to the following Electrical Safety standards: UL-1950, EN60950, and IEC 60950	5.5.3.3.13 (19)	R
	Standards Compliance Requirements	**5.5.3.3.14**	
367	ITU-T Recommendation G.691 (2006)	5.5.3.3.14 (1)	R
368	ITU-T Recommendation G.693 (2006)	5.5.3.3.14 (2)	R
369	ITU-T Recommendation G.707/Y1322 (2007)	5.5.3.3.14 (3)	R
370	ITU-T Recommendation G709/Y.1331	5.5.3.3.14 (4)	R
371	ITU-T Recommendation G.783 (2006).	5.5.3.3.14 (5)	R
372	ITU-T Recommendation G.826 (2002)	5.5.3.3.14 (6)	R
373	ITU-T Recommendation G.831 (2000)	5.5.3.3.14 (7)	R
374	ITU-T Recommendation G.841 (1998)	5.5.3.3.14 (8)	R
375	ITU-T Recommendation G.842 (1997)	5.5.3.3.14 (9)	R

Table 3-2. OTS and TSF Capability/Functional Requirements Table (continued)

ID	Requirement	UCR Ref (UCR 2008 CH1)	R/C
376	ITU-T Recommendation G.957 (2006)	5.5.3.3.14 (10)	R
377	ITU-T Recommendation M.2101 (2003)	5.5.3.3.14 (11)	R
378	ITU-T Recommendation G.7041/Y-1303 (2003) (2008)	5.5.3.3.14 (12)	R
379	ITU-T Recommendation G.7042/Y-1305 9 (2004) (2006)	5.5.3.3.14 (13)	R
380	ANSI T1.231-1993 [2003 (R2007)]	5.5.3.3.14 (14)	R
381	Telcordia Technologies GR-253-CORE, Issue 3, September 2000; (Issue 4, December 2005)	5.5.3.3.14 (15)	R
382	Telcordia Technologies GR-282-CORE, December 1997; (Issue 4, July 2006)	5.5.3.3.14 (16)	R
383	Telcordia Technologies GR-383-CORE, Issue 1, July 1997; (Issue 3, February 2006)	5.5.3.3.14 (17)	R
384	Telcordia Technologies GR-499-CORE, Issue 2, December 1998; (Issue 3, September 2004)	5.5.3.3.14 (18)	R
385	Telcordia Technologies GR-1230-CORE, Issue 4, December 1998	5.5.3.3.14 (19)	R
386	Telcordia Technologies GR-1400-CORE, Issue 2, December 1999 (Issue 3, July 2006)	5.5.3.3.14 (20)	R
387	Telcordia Technologies GR-2996-CORE, Issue 1, January 1999	5.5.3.3.14 (21)	R
388	Telcordia Technologies SR-3580, Issue 1, November 1995; (Issue 3, June 2007)	5.5.3.3.14 (22)	R
389	IEEE 802.3-2008, Section 5	5.5.3.3.14 (23)	R
390	IEEE 802.1Q-2003	5.5.3.3.14 (24)	R
391	IEEE 802.17-2004	5.5.3.3.14 (25)	R
392	British Standards Institute BS EN 60950-1, August 6, 2006	5.5.3.3.14 (26)	R
393	IEC 60950-1, 2006	5.5.3.3.14 (27)	R
394	CFR FCC Part 15, Class A	5.5.3.3.14 (28)	R
395	Network Equipment- Building System (NEBS), Level 3	5.5.3.3.14 (29)	R
396	Underwriters Laboratories, Inc UL-1950, Standard for Safety, Information Technology Equipment Including Electrical Business Equipment. 1ed, 1989	5.5.3.3.14 (30)	R

LEGEND:

AGF	Access Grooming Function
BER	Bit Error Rate
dB	Decibel
C	Conditional
DC	Direct Current
DCN	Data Communications Network
DISN	Defense Information Systems Network
DWDM	Dense Wavelength Division Multiplexing
EDC	Electronic Dispersion Compensation
EIA	Electronic Industries Alliance
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOL	End of Life
FCC	Federal Communications Commission
FDM	frequency-division multiplexing
GIG-BE	Global Information Grid-Bandwidth Expansion
GigE	Gigabit Ethernet
GR	Generic Requirement
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IR	Intermediate Reach
ITU	International Telecommunication Union
ITU-T	International Telecommunication Union-Telecommunication
km	Kilometer
LAN	Local Area Network
Mbps	Megabits per second
msec	millisecond
MSPP	Multiservice Provisioning Platform
NE	Network Element
NEBS	Network Equipment-Building System
nm	nanometer
OA	Optical Amplifier
OC	Optical Carrier
ODU	Optical Channel Data Unit
ODXC	Optical Digital Cross Connect
OLA	Optical Line Amplifier
ORL	Optical Return Loss
OSC	Optical Supervisory Channel
OSP	Open Shortest Path
OTS	Optical Transport System
OTU	Optical Transport Unit
OXC	Optical Cross Connect
R	Required
ROADM	Reconfigurable Optical Add/Drop Multiplexor
SDH	Synchronous Digital Hierarchy
SONET	Synchronous Optical Transport Network
STM	Synchronous Transport Module
TSF	Transport Switch Function
TTL	Transistor-transistor logic
UCR	Unified Capabilities Requirement
UHF	Ultra high frequency
UNI	User Network Interface
VHF	Very High Frequency
WAN	Wide Area Network